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NO. 191 (VOL. XXX) SEPTEMBER, 1935

JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

THE FOREIGN TRADE STATISTICS OF THE UNITED STATES

By Eliot G. Mears, *Stanford University*

The purpose of this article is to inquire into the utility of the United States foreign trade statistics. It is scarcely possible to exaggerate the significance of these trade barometers. Furthermore, unless it is possible to bring the data into mutual focus before the attempt is made to interpret them, their validity and usefulness is seriously curtailed. Intimately tied up with the precise nature of foreign trade movements are the formulations of governmental and private policies with respect to agriculture, industry, trade, transportation, finance, et cetera. Accuracy and comparability in these statistics are questions, therefore, of vital importance. The high standard attained by our foreign commerce statistics must be admitted; our goal here is to suggest ways and means for their improvement.

"Statistics," as Professor Wesley C. Mitchell wrote in the Quarterly Publications of the American Statistical Association, September 1918, "is an international enterprise. Washington is concerned both with the statistical output and with the statistical methods of London, Paris, and Berlin, of Buenos Aires, Wellington and Tokyo." Although a few examples are taken from abroad, it is beyond the scope of this article to go into details relative to the statistical procedures of foreign countries. Even the treatment of the United States must be limited, necessarily, to leading, broad features. The severe curtailment since 1932 in the statistical reporting services of the Bureau of Foreign and Domestic Commerce, and depression conditions are largely responsible for the nearly exclusive use in this article of statistics applicable to an earlier date. Furthermore, in view of the New Deal objectives, statistics applicable to the period 1926–1929 and to earlier years appear to warrant especial consideration. Com-

modity items appearing in the statistics of imports and exports receive the major attention, but certain "invisible" transactions are not overlooked.

DESIGNATION OF EXPORTS AND IMPORTS

What should be included under merchandise exports? What should be included under merchandise imports? Obviously, the failure to agree upon the inclusion or non-inclusion of the same commodities or other items both vitiates the trade balance of any one country and renders difficult or impossible international comparisons. This problem of major proportions, which faces us at the outset, must be met squarely, even though it is to be feared that a satisfactory solution is scarcely to be anticipated. While each country has the cogent reasons of history or tradition for continuing its methods of recording exports and imports, it is exceptional when such practices of any one country have remained sufficiently constant over a period of years to afford a satisfactory appraisement of its foreign trade. Records of foreign commerce are generally fiscal in their origin, hence lamentably unsuited to the needs of the business world. Examples, more or less glaring, can be gleaned from the official statistics of practically all countries despite the fact that foreign trade figures are among the earliest of economic statistics. Sensing the needs of commerce, progressive countries maintain virtually two sets of statistics based upon the identical goods, namely, one for the levying of duties, the other for commercial utility. When we realize that no two countries have identical classifications and practices in statistical compilation and no two countries have identical situations with respect to natural resources, industrial and agricultural requirements and commercial conditions, which must find expression in statistical materials and results, the complexities and perplexities relating to comparable world statistics are readily explained. Yet the need for betterment is none the less urgent. The most promising results are are to be sought in the further adoption of uniform nomenclature together with a more general agreement upon the various items which should comprise a country's exports and imports.

How complete are our foreign trade statistics? How accurate? What is the basis of comparability between import statistics and export statistics? What cautions should be observed? Although the writer's treatment of this important subject must be exceedingly brief, nevertheless the purpose of this article will be served if some

of the criticisms presented here are considered as timely warning signals.[1]

Commodities which occasion foreign trade transactions are mainly articles which involve commercial exchange, but even this definition is not broad enough, since, as the League of Nations reports, there may be omitted ships bought and sold, specie, fish from foreign boats, ships' stores outward, goods sent by post, purchases by the government, and so on. On the other hand, dutiable excess of passengers' baggage and transfer of machinery and supplies to branch factories abroad are not commercial transactions. Largest items in this list of non-uniform classification are gold and silver transactions, mail including parcel post, and those for vessel account, including bunker coal and oil. Again the necessity of suitable definition is apparent. The word "merchandise" in United States usage has been defined in the Act of March 3, 1875 (18 Stat. 469) and subsequently, as meaning "goods, wares and chattels of every description, and includes merchandise, the importation of which is prohibited." In the writer's judgment, however, the official United States tabulation of merchandise imports and exports fails to interpret this classification broadly enough, let alone correctly.

Gold and silver are surely visible items. Whether, in their various forms, they should be included among international commodity transactions is a debatable question. There is the greatest divergence in the practice adopted by different countries relative to the inclusion or exclusion of gold according to whether it is in raw, refined, or coined condition, or perhaps distinguishing, as in the case of the United Kingdom, between gold coin which is legal tender in Great Britain from other gold coin treated as bullion in another form. Some nations place silver in a category entirely separate from gold, partly because of the small amount now coined.

The general rule appears to be that the shipment of gold or silver in any form may constitute a considerable item in a country's ledger, as in the instance of Australia. In 1926, gold bars represented over 40 per cent of the total domestic exports of the Union of South Africa, and this figure did not include a heavy volume of gold and silver

[1] The literature on this subject is distinctly meagre. Few references are to be found in textbooks, government reports, proceedings of learned societies, or researches of special foundations. Available sources are: Frank R. Rutter, "Statistics of Imports and Exports," PUBLICATIONS OF THE AMERICAN STATISTICAL ASSOCIATION, Vol. XV, No. 16, (1916); M. Rosenthal, *Technical Procedure in Exporting and Importing* (1922); L. F. Schmeckebier, *The Customs Service* (1924); L. F. Schmeckbier, *The Statistical Work of the United States Government* (1925); G. B. Roorbach, *Import Purchasing* (1927); E. G. Mears, *Maritime Trade of Western United States* (1935), Chapters VII and XVI and Appendix D; and the publications of the International Statistical Institute at Brussels and the Economic and Financial Section of the League of Nations.

specie. The United States, on the other hand, lists separately gold and silver into ore and base bullion, refined bullion, United States coin and foreign coin, but these totals, always running into hundreds of million dollars annually, are omitted when comparisons are made with other countries. For example, the aggregate export of gold and silver for the United States for the calendar years 1928 and 1929 amounted to $648,000,000 and $200,000,000, respectively; the aggregate imports of gold and silver for the same years amounted to $237,000,000 and $256,000,000. Thus, if classed as merchandise, these gold and silver migrations, admirably compiled in a special table in *Foreign Commerce and Navigation*, would have increased our exports for 1928 and 1929 respectively by 12.6 per cent and 3.8 per cent; our imports by 5.8 per cent and 8.1 per cent; and our total foreign trade by 9.6 per cent in 1928 and 5.8 per cent in 1929. Any plan followed is subject to objections, but the margin of total error would be smaller if all countries refrained from attempts to draw questionable distinctions,[2] and more important still, comparability would be greatly improved.

Among the other international transactions listed under "Commodity Trade" in *The Balance of International Payments of the United States in 1930*, for example,[3] but not so handled in the annual *Foreign Commerce and Navigation* and the *Monthly Summary of Foreign Commerce*, are (stating all figures in millions of dollars): bunker coal and oil sales to foreign ships (credits 44, debits 10), ship chandling, ship repairs, and tonnage dues (credits 46, debits 31), sale of vessels (credits 3, debits 3), unrecorded parcel-post shipments (credits 18), adjustments for differences in year-end lags (credits 87), and other merchandise adjustments consisting primarily of smuggling, undervaluation of imports, bad debts, and special charges (debits 146). The Union of South Africa is among the countries which include as merchandise both bunker fuel and ship stores. Allowances for these items, but not including gold and silver, would affect the United States international trade balance slightly, and would increase total merchandise transactions by $435,000,000, or

[2] The Economic and Financial Section of the League of Nations took a surprisingly strong stand on this point. "The gold movement may be looked upon as a balancing item and is closely related to the capital account. Obviously, however, gold exported by gold-producing countries or imported for industrial purposes is merchandise and it is seldom possible to state with certainty that any given consignment of gold will be utilized for monetary purposes only. Gold has accordingly been treated throughout as any other commodity and entered into the current account—not when purchased or sold, but when physically imported into or exported from any country." *Memorandum on International Trade and Balance of Payments, 1926–1928*, Vol. II, p. 6.

[3] *The Balance of International Payments of the United States in 1931*, Trade Information Bulletin, 803 (1932) contains the revised statistics cited here.

6.6 per cent of the total recorded trade. Even these items do not cover all possibilities. Additions which might properly be made are purchases for government account, either at home or abroad for use in the United States or in some foreign outpost, whether for the military or the civil services.

In addition to merchandise omitted or irregularly classified in the import and export statistics of the United States, there are two major movements of incoming and outgoing goods, which, until comparatively recent years, have been entirely omitted. The first relates to the shipment of goods sent by mail and parcel post, which did not enter the custom house records but came under the direct jurisdiction of the Postmaster General. This situation was partially met by the Act of 1924, which required export declarations in the instance of packages, valued at $25 and upwards, sent by a business firm in the United States to a business firm abroad. Because of a cut in appropriations for the fiscal year 1934, the compilation and publication of these shipments has been discontinued since 1933. The misleading features, from a statistical standpoint, are the omissions under the stated minimum of $25 (which the department concerned claims are largely non-commercial and of small aggregate value), the inability to differentiate between a private individual and a business house abroad, and the omission from parcel-post imports of all non-dutiable packages as well as numerous dutiable ones. Exports by parcel post are listed separately, while imports by parcel post are not so recorded but are included under general imports. During 1930, our domestic imports and general imports by parcel post were estimated at $20,510,000 and $75,893,000, respectively. These past and present omissions in postal movements, either by understatement or by their failure to be recorded, invalidates these statistics.

TREATMENT OF LAND EXPORTS

The second notable omission is the failure of the government during the first century of its existence to make legal provision for export declarations for shipments by rail or vehicle to Canada and Mexico. This was not covered by the provisions of the Act approved February 10, 1820, when Congress, appreciating the need for more systematic foreign-trade statistics, established a Division of Commerce and Navigation in the Office of the Register of the Treasury, requiring Collectors of Customs to compile and transmit yearly reports to the Secretary of the Treasury. This enabling Act, the basis of our foreign commerce statistics, applied to exports shipped to foreign countries by *vessel* only.

So statistics of exports by land to Canada and Mexico were entirely neglected until the close of the fiscal year ending June 30, 1893—a a fact of which most historians appear ignorant and which invalidates findings upon such incomplete records. This grave omission in our statistics resulted in fresh legislation in 1893; unfortunately, however, these remedial provisions were not enforced, hence the trustworthiness of our export statistics in this respect for the years 1893–1915 inclusive is open to serious question. It was not until September 15, 1915, that new regulations were promulgated, known as Treasury Decision 35708, whereby there was accomplished the double feature of larger reported exports and also more satisfactory statistics.

In 1916, Mr. John Hohn, then Chief of the Statistical Division of the Bureau of Foreign and Domestic Commerce, wrote:

> The regulations have been in effect since February and on the whole have come up to the expectations and have resulted in a decided improvement of the export statistics. The total exports for February amounted to more than $400,000,000, an increase of $70,000,000 over January and $40,000,000 over December, 1915, up to that time the high-record month in the history of the country. How much of this increase is due to the new regulations, it is impossible to state, although various estimates placing it as low as 10 per cent and as high as 20 per cent have been made. It is safe to say, however, that at the present time a declaration prepared by responsible parties is furnished for practically every export shipment leaving the country, whereas it was known under the old order whole train loads crossed the border without being recorded in the statistics and that statistics collected at seaboard ports were grossly inaccurate.[4]

The situation, while greatly improved, is still some distance from perfection.[5] The size of this inadequately recorded traffic overland to our neighbors may be estimated from various angles: (1) of our total exports of foreign merchandise credited to Canada in the calendar year 1929, amounting to $83,000,000, over half was carried almost wholly by cars and other land vehicles, (2) the domestic exports in 1929 to Canada and Mexico amounted to $949,000,000 and $133,000,000, respectively, and (3) of the total domestic exports of domestic

[4] *Report of the Chief of Bureau of Foreign and Domestic Commerce*, 1916, pp. 315–317.

[5] "The marked similarity between American figures for exports to Canada and Canadian figures for imports from the United States suggests that goods in this trade are usually valued by both countries f.o.b. point of origin—despite the instructions to American customs collectors to require that export declarations include freight charges to boundary or to vessels. The discovery of the huge invisible American export involved is credited to S. Parkinson of Toronto University and Herbert Marshall of the Dominion Bureau of Statistics.

"A recent investigation by the division of statistics of this bureau (which compiles and publishes the export statistics of the United States) confirms the suspicion of serious errors in our export declarations. That division circularized American collectors of customs at Canadian landports through which 96 per cent of all American exports to Canada by rail passed in 1929. It found, in brief, that some export declarations (of coal and automobiles, for example) include freight to boundary, as prescribed in the statistical regulations; others do not. 'The statistical regulations are advisory and educational, and there is no way of enforcing them in this respect; collectors of customs lack personnel to examine export declarations carefully'. In value, roughly two-thirds of our exports by rail to Canada in 1929 'may have been value', exclusive of freight to border, that division concludes." *The Balance of International Payments of the United States in 1930*, p. 13.

merchandise in 1929, amounting to $5,157,000,000, one-sixth, or $846,000,000, was shipped in cars and other land vehicles. Thus, both with regard to unreported parcel-post transactions and overland rail movements, by and large our export totals have been considerably under-stated.

REGIONAL BASIS OF IMPORTS AND EXPORTS

One would expect to find that the recording of merchandise imports and merchandise exports is on a uniform basis; however, this statement is far from the truth. According to Customs Regulations 1273, the date of entry of merchandise is identical with the date of importation, while, according to Customs Regulations 1287, imports are credited not to port of first arrival but to the port where they are entered for immediate consumption or for the warehouse.[6] Exports, on the other hand, are credited solely to the port of final departure. Obviously, therefore, the official statistics of a region's imports and exports do not present a true test of its deficiencies and surpluses because of the confusion arising out of the varying commercial practices either in taking delivery of or in dispatching goods, and also the utter lack of comparability in import and export statistics upon other than a national basis. Furthermore, the compilation is for the 49 customs districts only, each of which embraces one to twenty-five ports, thus the failure to publish the tabulated statistics for each port adds to the unsatisfactory reporting of our international commerce. While these more refined statistics would involve a considerable extra financial outlay, the result should certainly justify the expenditure.

We must stress the point that the distribution of United States imports, by domestic localities, is so poorly reported because, under our laws, the importer or his representative may officially "enter" the goods at any "port"[7] of his choosing. This "port," perhaps, may be the first United States district which the goods physically entered, any business city, or the district of consumption, for the reason that the customs formalities and the commercial records based thereon apply to that optional customs district where the importer of merchandise chooses to arrange for a "consumption entry," or "warehouse entry," or "immediate transportation entry." In the event

[6] In 1912, the government made a trial schedule on these two bases, which disclosed that 7 per cent of all United States imports were officially entered at ports other than the place of first arrival. A current investigation might yield far different results. To the writer's knowledge, this is the only computation of this kind which has been attempted.

[7] A "port" may be a locality wholly inland. *Customs Regulations of the United States* (1929), p.l., defines a port of entry as "any place at which a customs officer is stationed with authority to enter and clear vessels and collect duties on imports." Consult also Chapters XVI and XVII in this manual.

of consumption entry, the goods, after being cleared, are entered among the general imports; for a warehouse entry, goods are entered in bond in one of the government warehouses designated for this purpose to suit the temporary need of the importer; for an immediate transportation entry the importer, by naming another port, serves notice that he does not wish to take delivery at the real frontier port, with the result that the goods are shipped in bond without appraisement to any of the more than 300 ports of entry which make up the 49 customs districts. For merchandise moving under an immediate transportation (I. T.) entry, the mere frontier port receives no statistical credit whatever for commodities which it handles, even though the collectors of customs have a complete record in their files. A record of immediate transportation shipments is kept, but not issued either locally or by the customs headquarters at New York. Thus, these statistics of United States imports are wholly unreliable, should we attempt to correlate the foreign commerce of any port or customs district with the physical movement of the commodities themselves. The nature and amount of sectional foreign trade come under the category of hidden entries.

Let us take as illustrations of this regional difficulty two of our leading import commodities, namely, raw silk and crude rubber. In 1929, raw silk amounting to 87,000,000 pounds valued at $427,000,000 was imported into the United States, principally from Japan. Practically all of the shipments entered the American Continent at Vancouver, Seattle, or San Francisco, for all-overland rail transit to the silk manufacturing centers in New Jersey, New York, and Pennsylvania. The all-water shipments via the Panama Canal were negligible, yet what do the general import statistics show? The customs district of Washington was credited with $151,000,000, San Francisco $92,000,000, New York $87,000,000, St. Lawrence $44,000,000, Rochester $37,000,000, et cetera. In other words, sometimes the import entry is completed at the first West Coast port, sometimes at the first United States port after transit through Canada (St. Lawrence, Buffalo), and sometimes at the metropolitan district or the actual location of the industrial plant. An investigation by the writer of the foreign tonnage arriving at San Francisco during the calendar year 1927 disclosed that the recorded imports and the "I. T." shipments at the port of San Francisco amounted to 55,370 and 29,275 tons, respectively, in the case of China, and 50,263 and 32,481 tons, respectively, in the case of Japan; on this basis, if volume and value were equivalent (never actually true), the value of San Francisco's incoming cargoes would be increased 53.3 per cent and 64.6 per cent

respectively from these two countries.[8] Unfortunately, official statistics are of negligible value in disclosing the fact that now raw silk from the Orient makes minor use of the transcontinental route, but normally is transhipped at a West Coast port on the all-water voyage to the industrial centers of eastern United States.

Imports of crude rubber, in 1929, totaled 1,262,000,000 pounds valued at $241,000,000, of which the New York customs district was credited with 1,075,000,000 pounds, valued at $206,000,000, and Ohio, the great production state for rubber goods, was credited with 44,000,000 pounds, valued at $8,000,000. Sometimes the imported merchandise may not even pass through the credited customs district. In practice, too, a distinction should be made between free goods and dutiable goods, since the payment of tariff duties and custom brokers' charges can be made more conveniently near the place of consumption, hence dutiable goods are more likely to move on an "I. T." permit. As a class, therefore, the statistics portray even less approach to commercial reality. The customs of the trade, too, are an appreciable factor in the choice of the port of entry—a situation which bears directly upon the particular locality which receives the credit for these imports.

Turning our attention now to exports, we find that an entirely different system of recording exists. In contrast to the importer, or his representative, who can pick the locality where he will exercise his will to "enter" merchandise, the exporter has little choice. He can make out his own export declaration or he can leave this formality to persons or firms located elsewhere. He is not under oath for shipments sent overland or valued less than $100. From the standpoint of statistical records, however, the regulations are clear and simple. The kinds, quantities, and values of exported merchandise are ascertained from the shippers' export declarations filled by the exporters with the collector of customs at the port of exportation. What is the result? The interior districts, ten in number, comprising Pittsburgh, Kentucky, Tennessee, Indiana, Iowa, Omaha, St. Louis, Minnesota, Colorado, Utah and Nevada, are officially listed as without a dollar's worth of exports. The value of general imports for these ten districts in 1929, however, was $35,000,000.[9]

[8] Eliot G. Mears, *San Francisco's Trans-Pacific Shipping*, Institute of Pacific Relations, New York, (1929) pp. 65–74.

[9] *Foreign Commerce and Navigation* (1929) Table No. VI, p. xiv. In the absence of further data of a first hand commercial character, these omissions on the export side and the questionable records on the import side not only make impossible an analysis of the foreign commerce of any interior point but also correspondingly vitiate exports and imports credited to the other customs districts.

STATISTICS BY STATES

Prompted by an organized demand from the Central and Midwestern States[10] for a statement which would show the exports from their region, the total export trade by individual states was issued in mimeographed form, quarterly and annually, from 1925 to July 1933, when they were discontinued, presumably for reasons of economy. Unfortunately, however, these statements, which always receive wide publicity, are not effective for even this useful purpose, for the reason that the statement by States is not based upon the place of growth or manufacture but rather upon the locality where the export declaration was prepared, as reflected in the through export bill of lading. To illustrate, conceivably all exports from Chicago or Cleveland might be credited to an Atlantic Coast or land border port. In each prepared statement, practically never heeded by the press or chamber of commerce, the Government gave this note of warning: "The following statistics are based upon through export bills of lading and do not provide a completely accurate index of the exact volume of export shipments from each state. The through bill of lading represents the only available source of information indicating the export standing, the relative position of the various states, and the figures are made public to meet the desire of business men for this type of information." The publication in newspapers, periodicals, and the more trustworthy sources usually failed to record these statistical limitations.

Actually, the tabulations by States are far from being "a completely accurate index" of the State's exports, which, after all, is the desideratum of this special report. Aside from the impossibility of securing the requisite data, consideration should also be given to the relatively small amount of exports which move on a through bill of lading, especially from the more isolated localities.[11] How also may one reconcile two sets of figures from the same governmental department? To the intelligent reader does "New York" signify the city, state, or customs district? To illustrate, in 1927 the merchandise exports from the New York customs district totaled $1,726,000,000, while the same Federal bureau announced that exports from the State of New York were valued at $770,000,000. On the other hand, the exports from the Ohio customs district were $32,000,000, and from the State of Ohio $186,000,000.

[10] *Annual Report of the Chief of the Bureau of Foreign and Domestic Commerce*, 1924.
[11] U. S. Bureau of Foreign and Domestic Commerce, *Uniform Through Export Bill of Lading*, Trade Information Bulletin 593 (1928).

ACCURACY AND COMPARABILITY

The relative accuracy of the import and export statistics of the United States can be described succinctly. A trained government statistician, the late Dr. Frank R. Rutter, stated in 1916:

> Among the public there is now a false sense of security in the correctness of import and export returns, because they constitute a by-product of customs administration. Customs officials, however, in their zeal to safeguard the revenue are prone to allow their attention to be diverted from these statistical data that do not directly affect the amount of import duty. There is considerable error in the statistics of dutiable imports; more in the statistics of free imports; and most of all in the statistics of exports.[12]

The situation has been considerably improved, however, under the Act approved January 5, 1923, whereby the control and expense of operation of the Section of Customs Statistics at New York was transferred from the Treasury Department to the Department of Commerce. The administration and clearance of incoming merchandise naturally is still vested in the Treasury Department. The Bureau of Foreign and Domestic Commerce, charged with the work of collecting, completing, and publishing the foreign commerce statistics, has now immediate access to the master statistical tables prepared at the New York Custom House from the export declarations and import entries forwarded there from all United States customs districts. Following the passage of this Act, larger appropriations, better quarters, and additional mechanical tabulating facilities became available. However, the situation has never been wholly satisfactory, and especially in the past two or three years has justified the frequent reference of the Chief of the Division of Statistics, Bureau of Foreign and Domestic Commerce, to the numerous errors in export declarations "due to the practice of exporters to leave the preparation of this document to forwarders or shipping agents at the port of exportation, or to intrust it to office boys or inexperienced clerks."

The greater attention which the Customs Service gives to the handling of imports, especially those subject to duty, and the carelessness of the individual business man in furnishing a sufficient description of export merchandise explain the greater trustworthiness of our import statistics. Import statistics are compiled from entries submitted by importers or their agents. Commodities are classified in accordance with the description appearing on the entry. Subsequently, the commodities are examined and in the case of dutiable imports appraised and liquidated. Frequently the appraiser may find

[12] PUBLICATIONS OF THE AMERICAN STATISTICAL ASSOCIATION, Vol. XV, 1916–17, pp. 20–21.

that the commodity falls in a different classification than that originally reported, or that the value has been reported as too small. Changes which are made in examination, appraisement, and liquidation are not carried into the statistics.

Mr. John Cummings, a statistician of the Census Bureau, wrote in 1918, that "except for exports by rail, it is probably true that our returns of exports have become progressively less accurate and complete, nearly in proportion as the volume of exports has increased."[13] The reason for this is not far to seek. Export declarations are prepared by exporters, or their agents, submitted to the Customs Office and one copy is then turned over to the transportation company. The transportation company, in most instances, apparently determines the rate to be charged for transporting the goods from the description appearing on the export declaration. Exporters frequently misdescribe their commodities in order to secure more advantageous freight rates. This, of course, causes inaccuracies and some confusion in commodity statistics, although total values of exports by customs districts and by countries are not affected unless the valuations are also misstated.

Until the creation of the commodity classification, effective in 1922, it was difficult and frequently impossible to compare imports and exports for the same class of goods. The former import classification was designed almost exclusively for the collection of tariff dues. The export classification, "although not made for tariff purposes, followed the same haphazard plan as the import classification. Partly alphabetical, partly according to groups of commodities, it followed no plan or order. The import and export classifications, as now used, while similar in their general characteristics, are two different classifications."[14] The features of the new classification, according to Professor Roorbach, are its primarily commercial character, the adoption of the decimal system of numbering, and the effort to render these trade statistics as comparable as possible with those in the fields of production and transportation. In 1915, there were 600 export classes and 3000 import items; the present satisfactory United States classification had 710 classes of imports and 1250 classes of exports in 1922, but so flexible has it become that 22 new import classes and 87 new export classes were added in 1929 alone, at the special request of the most interested industries. The classification is kept up-to-date.

[13] Koren, J., ed.: *The History of Statistics: Their Development and Progress in Many Lands*, (1918), p. 595.

[14] G. B. Roorbach, "A New Commodity Classification for Trade Statistics," *Official Report of the Seventh National Foreign Trade Convention*, (1920) pp. 541–58.

RECENT DEVELOPMENTS

Beginning with January 1934, the Bureau discontinued the compilation of general imports by commodity and substituted in its stead imports for consumption by commodity. The elimination of the "entry from warehouse" entries in the published statistics has removed the confusion relative to "imports for consumption" and "general imports." Formerly, the placing of dutiable goods in a bonded warehouse was recorded under general imports; if withdrawn for export, the transaction would be recorded under foreign exports, but if for later domestic consumption, the transaction would be recorded under imports for consumption. Despite the inherent objection of making comparability with previous years practically out of the question, the absence of practical objections and the removal of a dual system of reporting imports have fully justified this change.

The timeliness of reports is a never-ending topic. *Foreign Commerce and Navigation* has seldom appeared until nearly twelve months after the close of the calendar year; the volume for the calendar year 1933 did not appear until early in 1935. The limited facilities of the Government Printing Office and the priorities of Federal business are responsible doubtless.

Appropriations allotted to the Bureau of Foreign and Domestic Commerce for compiling foreign trade statistics were as follows: 1930, $366,000; 1931, $385,000; 1932, $390,000; 1933, $270,000; 1934, $244,000; and 1935, $246,000. During this depression period, it may be observed that there was an increase annually from 1930 to 1932, and a severe drop for the subsequent years. Actually, the disparity between these two three-year periods is considerably greater in reality, since the operating expenses amounted to approximately $429,000 in 1932 and only $229,000 in 1934, or a drop of 47 per cent in this essential function which cannot be relegated to any other public or private agency. The toll is severe. The outstanding *Commerce Yearbook*, which in 1932 consisted of one volume devoted to the United States and one to foreign countries, of 602 and 743 pages respectively, has dwindled to the *Foreign Commerce Yearbook*, with 358 pages in 1933. The Annual Supplement to the *Survey of Current Business*, of 311 pages in 1932, has been discontinued. The weekly, *Commerce Reports*, has been reduced from approximately 60 pages in 1932 to 20 pages in 1935. The *Monthly Summary of Foreign Commerce* has now somewhat less than fifty pages per issue, or half of its previous size. A computation prepared by the Department of Commerce reveals that, despite the tremendous decline in our export and import

totals, the United States takes practically last place among all nations with reference to the number of pages of statistics per million dollars of foreign trade which appear monthly in official foreign trade publications: for example, British India 45.8 pages monthly, Italy 43.5, France 29.6, China 24.4, U. S. S. R. 16.0, Germany 13.0, United Kingdom 8.0, and the United States 1.4.

A period of national uncertainty is precisely the time when it is uneconomical and unwise to curtail research and statistics. This action of our government is in striking contrast to the tremendous importance given to economic statistics by the U. S. S. R., illustrated by the position of their Central Statistical Board which enjoys the rights of a Commissariat with the head of the Board acting as a member of the government. It is to be hoped that the United States continues to deserve the tribute paid by Professor Ernst Wageman, President of the Statistical Bureau of the Reich, who, in the *Proceedings of the Geneva Conference on Economic Statistics* (1928, p. 128), cited the United States as "the country which took the foremost place in the world in regard to statistics." The depression has already had serious enough consequences in the greatly increased number of customs documents unsatisfactory for statistical purposes due to the efforts of foreign trade houses to reduce expenses as much as possible, without adding thereto a reduced personnel for receiving and checking these documents: as a result recent export and import statistics are less accurate than formerly. No number of coordinating or new Federal agencies can overcome the great handicap of unsatisfactory raw and worked statistics.

It is within the personal knowledge of the writer that the Washington authorities have, from time to time in recent years, proposed plans for improving the statistical machinery, but despite progress much remains to be done. The difficulties are intricate with respect to other government reporting agencies; moreover, the pressure brought by sectional and prejudiced interests has prevented a more clear cut presentation of the true state of affairs to be translated into statistical terms. Nevertheless, the officials of the Department of Commerce have established a well-deserved reputation for their continual willingness to improve these statistical services.

CONCLUSIONS

My leading conclusions regarding these statistics of imports and exports are these:

1. Adequate foreign trade statistics are necessary in the formulat-

ing of sound national and international economic and political policies.

2. The United States foreign trade statistics compare favorably with those issued by any country. From the standpoint of accuracy, the best foreign trade statistics are still for imports subject to duty, next free imports, and the least accurate are for exports.

3. The size and diversity of the country require that more attention be given to localities. The main statistical emphasis at present is upon the commodity, rather than the customs district, customs port, or individual port therein. The writer's conviction is that by far the greater demand for information comes from widely scattered urban centers, interested far more in metropolitan development than in commodity analysis which is primarily upon a national basis.

4. To meet the needs of foreign trade communities, statistics of exports and imports should be comparable. Exports may be said to be on a transportation basis, while imports are principally on a trade basis. Unless the outbound and inbound movements by regions (large or small) can be contrasted in fact, obviously impossible under existing conditions, sole dependence should be upon the trustworthy national data. The past and existing statistical tabulations with reference to customs districts are extremely misleading; the situation is aggravated since there appears almost no word of caution relative to the wholly different methods utilized in their computation. Upon the basis of the official trade returns, everyone should be wary of estimating both the quantity and value of foreign trade of any section of the United States.

5. The city or the metropolitan community, far from being treated statistically, is not even mentioned. While in extremely few instances their frontiers may coincide with the established customs districts, or customs ports, nevertheless even such statistics must be utilized with caution. It would be exceedingly valuable to learn the amount and value of foreign commerce of leading ports, New York, for example, instead of guessing what its share may be of the New York customs district, which comprises not only all of the State except the St. Lawrence-Buffalo-Rochester districts but also eight counties in New Jersey. Statistics for leading ports, rather than being merged and submerged as at present, should be included under each of the customs districts, and in as much detail as appropriations permit.

6. The extra labor and expense involved in reporting statistics for leading ports could be compensated largely, probably not entirely, by the separate omission of commodities of relatively small value nationally or locally. A much more liberal adoption of "miscellaneous"

groupings under each class of commodities, by requiring a minimum of $25,000 or $35,000 perhaps for mention, would enhance greatly the academic, commercial, and political utilization of our foreign trade statistics. This suggested procedure would prove of splendid aid in providing place and commodity relationships.

7. Tabulation of merchandise exports according to final port of departure should be maintained. In the one-page summary of exports and imports by customs districts (Table V in the 1933 volume), a brief note should be inserted to explain why several interior districts fail to be credited with any exports.

8. Merchandise imports should be recorded according both to official port of entry and port of landing. This second calculation might be confined, at the outset, to a summary table for each customs district based upon the inclusion of the "immediate transportation" data. The cost would be small and the possibilities for exploration great. It is a wise economy not to publish the "entry for warehouse" records, but to lump them under general imports.

9. A careful review should be made of the differentiation between "visible" and "invisible" items. Further data should be made available, in circulars and published form, regarding physical items which are not now classified as commodities.

10. Quarterly and annual statistics of exports by states of original shipment should not be revived.

11. Statistics should be compiled to show the exports and imports moving by air, land, and water routes.

12. The foreign statistical service of the Bureau of Foreign and Domestic Commerce must be supported by larger appropriations. The serious situation existing since 1932 is a direct challenge to all persons vitally interested in the compilation and issuance of indispensable statistical data.

13. Revisions should not be made in the foreign trade statistics until the cooperating facilities and special needs of other governmental agencies are carefully considered. Attention should be given to the requirements of business men and the suggestions of social science groups.

14. Although numerous, mentioned changes are highly desirable in the foreign trade statistical service of the United States, each new departure should be carefully considered in the light of past and present experience. Utility is to be regarded as a more significant factor than comparability, yet these two attributes are not necessarily opposed one to the other.

A STATISTICAL STUDY OF CLIMATE IN RELATION TO PULMONARY TUBERCULOSIS [1]

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INTRODUCTION

On September 1, 1934, the *Journal of the American Medical Association* commented editorially on the present status of the age-old impression that climate has significance in the treatment of various diseases, notably tuberculosis. The editor concluded that, while a considerable body of opinion now tends to minimize the importance of climate, nevertheless a belief that has existed so long and persistently in all probability has some foundation in fact. The suggestion was made that the need for a more exact knowledge of the influence of this factor constituted a challenge to the medical profession.

In 1923 Gardiner, Webb, and Ryder,[2] published a study in which they concluded, on the basis of relatively limited statistical data for 21 states, that the high inland plateau region of the United States had a remarkably low death rate from tuberculosis, and that this appeared to be due, in considerable part, to climatic factors, notably altitude and dryness.

Tuberculosis morbidity and death rate statistics for the native population of Switzerland, reported by Gwerder [3] for altitudes varying from 600 to 6000 feet, indicated that the rates declined with increase in altitude. Grau [4] and Van Oordt [5] reported results for Swiss sanatoria varying in altitude from 1300 to 4300 feet which indicated no pronounced difference attributable to altitude. Treutlein's [6] figures for hospitals in Bolivia, at altitudes of 6000 to 12,000 feet, indicated that the proportion of tuberculous cases declined sharply with increase

[1] Presented before a joint session of the Social Science and Medical Sections of the American Association for the Advancement of Science at Pittsburgh, Pennsylvania, December 28, 1934. For criticism and suggestions the authors are indebted to Charles F. Roos, Professor of Econometrics at Colorado College, Harold T. Davis, Professor of Mathematics at Indiana University, Dr. Charles H. Boissevain of the Colorado Foundation for Research in Tuberculosis, and William F. C. Nelson of the Cowles Commission for Research in Economics.

[2] C. F. Gardiner, G. B. Webb, and C. T. Ryder, "Tuberculosis Mortality in Relation to Altitude, Humidity and Density of Population," *American Review of Tuberculosis*, Vol. 8 (1923), pages 112–121.

[3] J. Gwerder, "Ansteckungsgefahr an Lungenkurorten und Tuberculosevererbung," *Beitrage zur Klinik der Tuberculose*, Vol. 25 (1912), pages 61–81.

[4] H. Grau, "Ergebnisse der Heilstattenbehandlung in Volksheilstatten," *Therapeutische Monatshefte*, Vol. 27 (1913), pages 401–406.

[5] M. Van Oordt, *Physikalische Therapie Innerer Krankheiten*, Berlin (1920), pages 193–5.

[6] Adolph Treutlein, "Das Vorkommen der Lungentuberculose in Bolivia und der Einflusz des Dortigen Klimas auf Zugereiste Phthisiker," *Deutsches Archiv fur Klinische Medizin*, Vol. 100 (1910), pages 88–93.

in altitude. Schröder [7] reported from a variety of sources 12,303 cases treated in Europe, pointing to slightly better results for moderate altitudes than for high altitudes or sea level. But in this report evidence as to homogeneity of data for the various localities is inadequate. Williams [8] from observation of 954 cases from his own private practice, reported a marked superiority for results secured at high altitudes as against the French Riviera and other low altitude resorts. Miller,[9] from observation of 1028 cases from his private practice referred to various health resorts in the United States, concluded that practically identical results might be expected in each locality. However, a statistical analysis of his data [10] gives grounds for questioning this conclusion and indeed shows some evidence of superiority for resorts over 5000 feet in altitude as against those under 2500 feet.

Some of the foregoing studies deal with tuberculosis death and morbidity rates for the entire population, while others are concerned with results secured in treatment of the disease. It should be noted that factors of significance in the latter are, in general, of importance in the case of the former, although the converse is not necessarily true.

Most of the reports cited seem to indicate that altitude is of importance. There is, however, some evidence of disagreement and, chiefly because an inadequate number of variables was taken into consideration, none of these studies seems convincing. The present authors have, therefore, undertaken a comprehensive investigation, based on more than 150,000 deaths from pulmonary tuberculosis, in order to determine to what extent available data reveal any significance for climate in determining the variation in the death rate among the white populations of the different states in the United States.

THE DATA

Included in the analysis were all of the 46 states in the Registration Area [11] with the exception of New Mexico, Arizona, California, and Nevada. These were excluded on the ground that their tuberculosis death rates were not comparable with those of the other states because of the presence of health seekers from outside their borders.[12] State

[7] G. Schröder, "Klimatische Behandlung," *Handbuch der Tuberculose*, Vol. 2 (1914), pages 330–375.

[8] C. Theodore Williams, *Transactions of British Congress on Tuberculosis in 1901*, Vol. 3 (1902), pages 4–15.

[9] James Alexander Miller, "Climate in the Treatment of Pulmonary Tuberculosis," *American Review of Tuberculosis*, Vol. 18 (1928), pages 523–550.

[10] Alfred Cowles 3rd, "A Statistical Analysis of Miller's Data on Climate in the Treatment of Pulmonary Tuberculosis," presented before the Rocky Mountain Tuberculosis Association at Colorado Springs, Colorado, September 18, 1934.

[11] No mortality statistics were available for South Dakota or Texas because they were not included in the Registration Area in 1928–29–30.

[12] In the case of New Mexico, Arizona, and California, an additional reason why the death rates are not comparable is that large numbers of Mexicans are included in the popula-

health departments, in these four instances, were unable to provide information regarding non-resident tuberculosis mortality or morbidity. In the case of Colorado, however, which also has large numbers of health seekers from other states, tuberculosis morbidity figures are available in the reports of the State Board of Health for the seven years, 1922–1928. These records group the cases in three categories, as follows, 86 per cent developed outside of Colorado, 3 per cent in Colorado, and 11 per cent origin unknown. In the present study the 11 per cent of which the origin was unknown were added to the 3 per cent developed in Colorado and the reported death rate from pulmonary tuberculosis for the state was accordingly multiplied by .14 in order to eliminate the effect of immigrated health seekers. The rate derived was 15.9 per 100,000 population. The 11 per cent thus added to the "developed in Colorado" group provides ample allowance for Colorado veterans reported as having contracted tuberculosis outside the state, and also for any cases contracted in Colorado which subsequently left the state. Instances of the latter sort must be rare since several Colorado tuberculosis specialists, consulted on this point, were unable to recall a single case falling in this category.

The evidence as to Colorado morbidity receives support from a study by Sewall [13] showing that, for 13 years prior to 1921, there was in Colorado an average of 30.8 deaths from tuberculosis, all forms, developed in Colorado, per 100,000 population, 150.5 from outside of Colorado, and 27.5 place of origin unknown. Adding 17 per cent (the most probable proportion of cases contracted in Colorado) of the "place of origin unknown" group to the "developed in Colorado" group, we secure an adjusted Colorado tuberculosis death rate of 35.5. The average rate for the entire registration area of the United States for this period was 147.5. The Colorado rate, as derived above, was 24.1 per cent of the national rate. The 1928–30 average death rate from pulmonary tuberculosis for the white population of the entire registration area of the United States was 55.8. If the same proportion, 24.1 per cent, held for Colorado in the later period, we should arrive at a death rate from tuberculosis developed in Colorado of 13.4,

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tions of these states. No conclusive figures are available on the tuberculosis death rate of Mexicans resident in the United States, but there is reason to believe that it is very much higher than for the white population exclusive of Mexicans. Dr. Benjamin Goldberg, in a paper entitled "Tuberculosis in Racial Types with Special Reference to Mexicans," *American Journal of Public Health*, Vol. 19 (1929), pages 274–286, reported the results of an investigation indicating that the Mexican pulmonary tuberculosis death rate for 1927 in Chicago was about 8 times the rate for the white population exclusive of Mexicans.

[13] Henry Sewall, "A Statistical Study of Tuberculosis Mortality in Colorado for the Thirteen Years 1908 to 1920," *American Review of Tuberculosis*, Vol. 7 (1923), pages 445–457. No. 47 of Reprint and Circular Series of the National Research Council.

which substantially confirms the figure of 15.9 derived from the 1922–1928 morbidity reports. Correspondence with the health departments of states showing abnormally high tuberculosis mortality, other than the 5 exceptions noted, indicated that their rates were not affected by the presence of non-resident health seekers. The final study, therefore, was based on the records of 42 states.

While the migrant health seekers constitute a large fraction in the few and sparsely populated western health resort states, they are an insignificant element in the more numerous and, in general, more densely populated states of origin. The fact that the tuberculosis death rates for the latter are undoubtedly slightly reduced by the migration may, therefore, be safely ignored. In any case, data on the migrants are not available regarding their distribution by states of origin.

In the analysis 19 elements were considered which, on the basis of *a priori* reasoning, might be expected to influence the tuberculosis death rate. The following series for each of the 42 states were prepared, the figures being based largely on the most recent data published by various departments of the Federal government:

(1) Pulmonary tuberculosis death rate *for the white population*[14] (1928–29–30 average) per 100,000 white population, standardized with respect to age distribution.

(2) Per cent of population colored, excluding Mexicans. Since the negroes have a very much higher tuberculosis death rate than the whites, it seemed probable that the danger of infection for whites might be greater in states having a larger proportion of negroes in their population.

(3) Per cent of white population illiterate 10 years of age and over. This represents standards of education.

(4) Expenditure in dollars of public elementary and secondary

[14] Since the tuberculosis death rate by age groups for the white population is only reported in the Mortality Statistics of the United States for 13 states having more than 10 per cent colored population, it was necessary in the case of the remaining states to effect the standardization with respect to age distribution using white and colored deaths combined, and subsequently to remove from the index the effect of the colored deaths. To accomplish this the following series were constructed: series A—the 1930 death rate by states for the total population, unstandardized with respect to age distribution; series B—the 1930 death rate for the total population, standardized with respect to age distribution by multiplying the death rate for each age group for each state by the corresponding percentage of the population of the United States falling within that age group and summing for each state separately the products thus secured; series C—the white death rate (1928–29–30 average) unstandardized with respect to age distribution, computed in the case of each state by dividing the annual average of white deaths (which included Mexican deaths) by the total of the white and Mexican populations from the 1930 census, the latter figure being adjusted downward by the amount of one year's population growth as estimated in the case of each state from the 1920 and 1930 census figures; series D—the final index of white deaths, standardized with respect to age distribution, represented, in the case of each state, by the value for D derived from the equation $D = C\,(B/A)$, where A, B, and C, are the corresponding values from the series defined above.

schools per capita of population 5 to 17 years of age, inclusive. This also represents standards of education.

(5) Occupational index.[15] This shows variations among the different states between the proportion of the population engaged in farming on the one hand, with its outdoor life, and manufacturing and mining on the other, with their more confined conditions.

(6) Hours of sunshine. Average number of hours of sunshine per day computed from the average for each of the 12 months. Together with altitude, this is the principal determinant of the annual amount of actinic radiation for any given point.

(7) Altitude in feet. For small or flat states this was computed by tabulating the altitudes of the 20 largest towns in each state, weighting these altitudes by population, and averaging these items. For large and mountainous states, in addition to using the 20 largest towns, the altitude of each county was estimated from publications of the Geologic Survey and road maps, and weighted in accordance with its population, exclusive of the 20 towns referred to. Altitude measures, to a large extent, actinic radiation and evaporation rate, and also certain physiological phenomena.

(8) Annual precipitation in inches. This was based on the average of the 15 largest towns, weighted in accordance with their populations. It has some bearing on the evaporation rate and also on mode of life.

(9) Daily temperature range in degrees Fahrenheit. This was computed as in the case of Series 8. The stimulating effect of wide daily variations in temperature might conceivably be beneficial.

(10) Death rate from all causes other than pulmonary tuberculosis, violence, and accident, per 100,000 *white* population, 1928–29–30 average, standardized with respect to age distribution. This has the interesting feature of largely eliminating from the death rate of each state the bias introduced by interstate and international migrations. It represents the general health situation.

(11) Population density per square mile. This measures potential risk of infection due to crowding.

(12) Latitude in degrees. This was computed by tabulating the latitudes of the 20 largest towns in each state and averaging these 20 items, each weighted in accordance with the population of the town represented. It might be assumed that excessive heat would constitute

[15] This index was based in part on data from *Death Rates by Occupation*, edited by Jessamine S. Whitney, published in June 1934 by the National Tuberculosis Association. From the 1930 census there was determined for each state the per cent of the white population represented by males engaged, on the one hand, in agriculture, and on the other, in manufacturing and mining. The former group was assigned the observed pulmonary tuberculosis death rate of approximately 40 and the latter the observed rate of approximately 100. The index for the state was then the observed rate for the entire white population of the United States, adjusted to give effect to the rates indicated for the groups in question.

a debilitating factor, or else that prolonged periods of excessive cold might enforce living conditions conducive to infection. This series was also investigated for evidence of non-linear correlation on the assumption that extremes of both heat and cold might be unfavorable.

(13) Average annual temperature. This was computed as in the case of Series 8, and its significance is similar to that of Series 12.

(14) Relative humidity in per cent. This was calculated as averages for January and July, at 8 A. M. and 8 P. M. It reflects fairly adequately the evaporation rate.

(15) Per cent of white population classed as urban. This measures potential risk of infection due to crowding.

(16) Per cent of white population foreign-born. Because the native countries of the immigrants have, in general, substantially higher tuberculosis death rates than the United States, it seemed probable that a larger proportion of the foreign-born than of Americans would be infected, or else that immigrants, as a class, might tend to be more rugged and, hence, less subject to tuberculosis than the average of native populations. Because of the prevalent belief that certain nationalities have relatively low immunity to tuberculosis, this series was also investigated in order to determine whether any significance attached to the representation of various countries in the foreign-born population of each state.

(17) Per capita personal income in dollars, 1929, from *America's Capacity to Consume*, by Leven, Moulton, and Warburton (Washington, 1934).[16] This represents standards of living and, to some extent, crowding associated with housing conditions.

(18) Expenditures in dollars of universities, colleges, and professional schools, per capita of population 18 to 23 years of age. This represents standards of education.

(19) Annual temperature range in degrees Fahrenheit. This was computed as in the case of Series 8. A certain tonic effect might derive from wide variations in temperature. This series was also considered in relation to average annual temperature as an additional check on the significance of extremes of heat and cold.

(20) Average wind velocity, miles per hour. In part this determines the amount of dust in the atmosphere, thus having a possible bearing on infection and the amount of actinic radiation.

Series 1 and 10 were based on the mortality statistics for the United

[16] Because there is considerable variation from year to year in the distribution of the national income by states, it seemed desirable to verify the evidence of 1929 by an examination of current annual income (1919–20–21 average) from *Income in the Various States*, by Maurice Leven, New York, 1925. In neither instance was there any significant correlation with the tuberculosis death rate.

States and the census reports, and Series 2, 3, 4, 11, 15, 16, and 18, on the 1930 census. Series 8, 9, 13, and 19, were derived from reports of the United States Weather Bureau, being averages for the entire period for which weather observations are available. Series 6, 14, and 20 were taken from the *Weather Atlases* of the United States Department of Agriculture.

These series, identified by number, are presented in Table I. Apart from the pulmonary tuberculosis death rate, they may be classified in two main groups, Series 2, 3, 4, 5, 11, 15, 16, 17, and 18, being non-climatic and Series 6, 7, 8, 9, 12, 13, 14, 19, and 20, climatic. Series 10, the death rate from all causes other than pulmonary tuberculosis, violence, and accident, falls between the two groups, since it might presumably reflect both climatic and non-climatic influences.

THE METHOD

The first step in the analysis was to compute by the usual formula the simple correlation coefficients between the tuberculosis death rate and each of the 19 primary variates. These are reported in Table II. On the basis of these coefficients, 7 series which appeared to lack significance were eliminated. The variates thus rejected were (2) per cent of population colored (later found to be significant), (15) per cent of white population urban, (16) per cent of white population foreign born, (17) per capita income, (18) expenditures for higher education, (19) annual temperature range, and (20) average wind velocity. Simple correlation coefficients between each pair of the remaining 12 primary variates, a total of 66 coefficients, were then computed (*see* Table II), and this resulted in the elimination of two more on the ground that they were linearly dependent on other series. The two thus rejected were (12) average latitude and (14) relative humidity, which showed very high correlation with (13) average annual temperature and (7) altitude, respectively.

It has long been known that multiple correlations involving highly intercorrelated variates may yield spurious results due to the vanishing, or near vanishing, of the correlation determinant. In a recent monograph, Ragnar Frisch considers this problem at length and suggests certain test rules, which he derived heuristically, for determining when spurious variates have been included in a regression.[17] His tests, involving determinants of simple correlation coefficients as well as other

[17] Ragnar Frisch, *Statistical Confluence Analysis by Means of Complete Regression Systems*, Oslo, 1934. For an earlier paper on the subject, see Barbara Burks, *Journal of Educational Psychology*, November and December 1926, pp. 532–540 and 625–630. See also Harold Hotelling, "Analysis of a Complex of Statistical Variables into Principal Components," *Journal of Educational Psychology*, 1933.

TABLE I
DATA BY STATES FOR VARIATES INCLUDED IN STUDY

State	(1)	(2)*	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Alabama	54.1	35.7	4.87	26	51.0	7.4	206	52.8	19.7	1050	52	33.1	63.8	77.5	28.0	.9	331	23	33.8	7.0
Arkansas	60.4	25.9	3.49	25	49.6	7.8	341	47.7	21.1	935	35	34.7	62.3	75.2	21.3	.7	311	17	39.3	8.0
Colorado	15.9	1.6	1.67	94	49.6	8.7	5358	15.8	26.4	1010	10	39.3	49.9	55.7	51.0	8.9	690	56	41.8	9.0
Connecticut	54.0	1.9	4.51	89	57.0	7.1	106	46.0	17.1	984	333	40.6	49.7	75.5	70.2	24.3	1008	163	45.0	9.0
Delaware	53.6	13.7	2.52	88	54.9	7.0	24	43.7	18.1	1027	121	39.9	54.2	77.0	52.5	8.2	1315	64	41.4	9.0
Florida	41.0	29.5	2.13	49	53.4	7.8	35	53.3	16.3	962	27	28.1	71.7	80.7	53.0	5.7	548	35	21.0	9.3
Georgia	43.9	36.8	3.35	21	51.0	7.4	651	48.5	18.5	1051	49	33.1	62.6	77.5	31.5	.8	343	26	33.6	8.0
Idaho	25.6	1.5	.69	81	51.0	7.8	3500	15.9	24.6	839	5	43.6	48.6	60.5	29.3	7.0	609	40	43.2	7.8
Illinois	48.3	4.4	2.27	87	55.8	7.3	597	33.6	15.1	1019	136	41.6	48.6	73.0	72.9	16.8	987	60	49.1	9.1
Indiana	53.9	3.5	1.42	81	54.3	7.1	676	38.0	18.5	968	90	40.4	51.9	73.0	55.5	4.3	614	55	47.2	8.8
Iowa	26.6	.7	.71	83	51.0	7.5	683	31.0	19.8	800	44	41.6	48.6	73.5	39.6	6.8	485	66	55.1	9.0
Kansas	27.4	3.7	.77	81	51.5	8.4	1039	33.3	20.6	826	23	38.4	55.4	69.3	38.8	3.9	569	48	49.3	10.5
Kentucky	85.8	8.7	5.66	30	51.3	7.0	536	43.3	18.8	990	65	38.2	56.6	75.0	28.6	.9	398	26	43.7	8.5
Louisiana	54.2	37.1	7.71	36	52.2	7.7	41	55.6	15.8	1045	46	30.5	68.6	77.8	43.5	2.6	438	26	29.2	8.0
Maine	47.8	.3	2.65	57	54.9	6.5	87	42.1	18.4	1009	27	43.5	44.2	77.0	40.3	12.6	645	43	49.0	9.1
Maryland	65.2	17.0	2.25	61	55.8	7.1	148	41.4	16.7	1087	164	39.3	55.2	73.0	60.1	7.0	799	74	42.2	8.0
Massachusetts	56.3	1.3	3.50	87	58.0	6.9	103	42.5	16.0	1134	529	42.1	48.0	74.5	90.2	25.2	975	119	45.2	10.0
Michigan	45.0	3.7	1.92	100	55.9	6.3	635	31.9	16.7	1027	84	42.1	47.9	77.8	68.0	18.1	869	45	48.5	10.0
Minnesota	42.7	.8	1.17	79	51.8	7.0	842	28.0	18.2	854	32	45.2	43.6	78.3	49.1	15.3	610	68	59.3	11.7
Mississippi	43.5	50.4	2.75	28	49.3	7.5	219	53.5	21.4	1010	43	32.3	64.9	77.3	20.5	.7	287	24	33.3	7.0
Missouri	53.5	6.3	1.81	65	52.5	7.7	604	38.5	17.9	959	53	38.7	55.0	74.3	51.0	4.4	675	47	47.8	9.1
Montana	44.4	3.2	.96	97	51.8	7.2	3923	14.6	24.4	914	4	46.5	43.8	66.0	34.5	14.1	698	40	41.9	8.0
Nebraska	19.5	1.4	.98	76	50.3	8.1	1364	27.8	21.0	818	18	41.0	50.6	67.8	34.7	8.5	521	46	54.7	10.7
New Hampshire	45.0	.2	2.67	63	56.2	6.7	316	38.8	20.0	972	51	43.2	45.0	73.8	58.7	17.8	652	96	49.1	8.0
New Jersey	53.6	5.2	3.77	119	58.9	6.7	63	46.1	18.1	1039	538	40.4	52.6	75.5	82.6	22.1	1002	23	44.4	9.0
New York	57.0	3.5	3.72	129	57.2	6.9	127	39.7	16.5	1112	264	40.7	50.4	75.3	83.2	26.3	1365	63	45.4	8.9
North Carolina	56.3	29.5	5.62	36	51.5	7.4	678	45.9	21.1	1101	65	35.3	59.4	75.7	25.2	.4	317	35	35.1	8.5
North Dakota	26.5	1.3	1.23	81	48.4	7.1	1297	18.9	22.6	790	10	47.9	39.3	73.8	16.7	15.7	422	40	62.9	12.1
Ohio	47.7	4.6	2.07	91	55.9	6.6	681	37.4	19.6	985	163	40.7	51.0	74.5	66.8	10.2	795	60	45.3	8.0
Oklahoma	42.1	11.1	1.79	47	51.7	8.0	990	36.0	22.8	859	34	35.6	60.5	69.5	34.7	1.3	503	30	43.1	11.0
Oregon	35.4	1.6	.73	91	53.8	7.1	615	39.7	18.0	869	10	44.9	52.2	69.8	51.5	11.3	757	78	28.8	6.8
Pennsylvania	51.3	4.6	3.04	72	57.3	6.1	400	39.9	15.9	1095	215	40.3	53.1	75.0	67.8	13.4	815	51	43.8	7.5
Rhode Island	52.9	1.5	4.87	78	58.2	7.0	53	44.2	15.0	1092	644	41.8	49.4	78.3	92.4	25.2	881	43	45.2	12.0
South Carolina	41.9	45.7	5.13	26	51.9	7.5	429	47.3	20.1	1175	57	34.1	63.2	76.8	24.6	.6	261	29	34.3	8.0
Tennessee	93.0	18.3	5.38	30	51.0	7.3	572	48.8	18.5	1027	63	35.6	60.0	75.0	30.7	.6	346	38	38.9	7.3
Utah	24.9	1.5	.66	76	53.3	8.5	4850	15.7	22.6	971	6	40.7	50.9	53.5	52.9	8.8	600	52	46.7	7.2
Vermont	56.0	.2	2.15	65	53.2	6.3	408	35.0	16.5	979	39	43.9	43.0	77.5	33.0	12.0	633	69	52.0	8.0
Virginia	63.3	26.9	4.87	33	52.4	7.2	290	41.6	15.5	1016	60	37.2	58.1	75.3	32.3	1.3	431	50	38.2	7.7
Washington	46.8	2.6	.79	94	54.8	5.9	455	33.8	15.9	861	23	47.5	50.5	73.8	56.7	16.1	841	50	31.0	6.8
West Virginia	61.7	6.7	4.32	54	54.8	6.1	863	42.4	22.9	963	72	39.1	54.6	78.8	28.5	3.2	485	25	41.2	8.0
Wisconsin	45.4	.8	1.79	73	53.4	6.9	670	30.6	16.3	892	53	43.4	45.6	75.8	52.9	13.3	682	45	51.5	9.5
Wyoming	21.2	2.0	.70	112	52.2	8.1	5380	13.1	26.6	860	2	42.7	44.4	58.5	31.1	9.2	777	48	44.9	7.3

*Prior to adjustment

TABLE II

COEFFICIENTS OF CORRELATION BETWEEN VARIATES 1 TO 14, INCLUSIVE*

Variates	Tuberculosis death rate	Per cent illiterate	School expense	Occupational index	Sunshine	Altitude	Precipitation	Daily temperature range	Death rate all causes	Population density	Latitude	Average annual temperature	Relative humidity
	(1)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(Y2) Per cent colored (adjusted)	+.510	+.048	+.044	+.176	−.089	−.091	**	**	**	**	**	**	**
(3) Per cent illiterate	+.680	—	−.540	+.123	−.159	−.463	+.722	−.340	+.679	+.335	−.569	+.532	+.515
(4) School expense	−.398	−.540	—	+.488	−.148	+.314	−.568	+.038	−.238	+.324	+.693	−.686	−.358
(5) Occupational index	+.274	+.123	+.488	—	−.586	−.347	+.212	−.573	+.454	+.739	+.260	−.246	+.259
(6) Sunshine	−.477	−.159	−.148	−.586	—	+.539	−.261	+.527	−.238	−.306	−.391	+.305	−.608
(7) Altitude	−.581	−.463	+.314	−.347	+.539	—	−.819	+.775	−.333	−.341	+.260	−.322	−.914
(8) Precipitation	+.638	+.722	−.568	+.212	−.261	−.819	—	−.574	+.567	+.298	−.678	+.711	+.780
(9) Daily temperature range	−.511	−.340	+.038	−.573	+.527	+.775	−.574	—	−.413	−.445	+.064	−.126	−.685
(10) Deaths, all causes	+.520	+.679	−.238	+.454	−.238	−.333	+.567	−.413	—	+.493	−.417	+.354	+.350
(11) Population density	+.286	+.335	+.324	+.739	−.306	−.341	+.298	−.445	+.493	—	+.085	−.108	+.271
(12) Latitude	−.264	−.569	+.693	+.260	−.391	+.260	−.678	+.064	−.417	+.085	—	−.944	−.285
(13) Average annual temperature	+.306	+.532	−.686	−.246	+.305	−.322	+.711	−.126	+.354	−.108	−.944	—	+.304
(14) Relative humidity	+.591	+.515	−.358	+.259	−.608	−.914	+.780	−.685	+.350	+.271	−.285	+.304	—

* Six additional variates were omitted from the multiple correlation analysis because they had low simple correlations with the tuberculosis death rate and with residuals derived from the multiple regression equation. The simple correlations with the tuberculosis death rate were as follows: (15) Per cent urban, +.085; (16) Per cent foreign born, −.106; (17) Per capita income, −.013; (18) Expense for higher education, −.038; (19) Annual temperature range, −.230 and (20) Wind velocity, −.214.

** Not calculated.

computations, are, however, too laborious to be applied to a problem including as many as 10 primary variates.

In the present study, a method of minimalization in different directions through iteration [18] was employed in a limited way as a preliminary step in eliminating redundant variates because, under the circumstances, it involved less labor than other methods. Thus, the first approximation of the regression function was derived by combining the 10 remaining primary variates in pairs, 4 of the resulting 5 regression functions being similarly reduced to 2, and so on, till one regression function representing the 10 variates was derived. The following regression equation of two variates x and z on a third variate y, which in this case was the tuberculosis death rate, was used:

$$\frac{y-A_y}{\sigma_y}=a_1\left(\frac{x-A_x}{\sigma_x}\right)+b_1\left(\frac{z-A_z}{\sigma_z}\right)$$

where

$$a_1=\frac{r_{xy}-r_{xz}\,r_{yz}}{1-r^2_{xz}},\text{ and }\ b_1=\frac{r_{yz}-r_{xy}\,r_{xz}}{1-r^2_{xz}}.$$

Obviously, a regression formula for several series, built up in this way, would not give the best possible fit for the 10 variates, since only regression coefficients of combined, and not of individual series, would be changed in successive building up stages. Therefore, a second approximation was obtained by the following procedure:

If $x_1 \ldots x_{10}$ represent the 10 primary variates, and y the dependent variate, in this case the tuberculosis death rate, then, y is approximately $\Sigma a_i x_i$ $(i = 1, 2, \ldots, 10)$ where the a_i are the coefficients obtained by the method described above. To correct a_1, the quantity $y - \Sigma a_i x_i$ $(i = 2, 3, \ldots, 10)$ was calculated and correlated with x_1, and a'_1 was thus obtained. The next step consisted of calculating $y - a'_1 x_1 - \Sigma a_i x_i$ $(i = 3, 4, \ldots, 10)$ and correlating this with x_2, thus obtaining a'_2. By carrying out this process for all variables $x_1 \ldots x_{10}$, a new set of coefficients $a'_1 \ldots a'_{10}$ was obtained. This second approximation was then followed by third and fourth approximations derived in similar fashion. On the basis of the above analysis, it appeared that 3 of the 10 primary variates had no independent significance, their signs having changed during the iteration. The three variates thus eliminated were (10) death rate from all causes, (11) population per square mile, and (13) average annual temperature. At this stage a multiple correlation

[18] C. F. Roos, "What do Time Series Correlation Coefficients Show?" Paper presented at the Pittsburgh meeting of the A.A.A.S., December, 1934.

coefficient of .792 for the 7 remaining primary variates with the tuberculosis death rate was obtained.

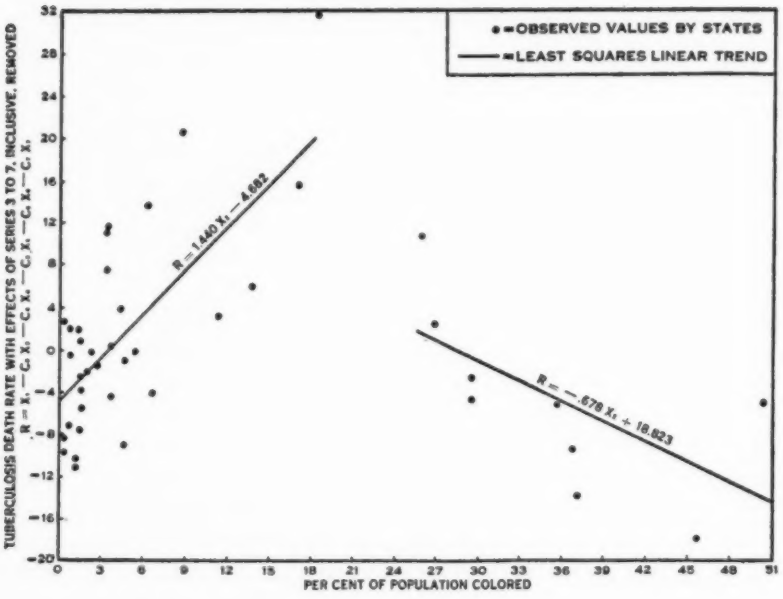
With the problem thus simplified, it became possible to resort to the more orthodox method employing determinants.[19] The start was made with 2 of the remaining 7 primary variates, all partial and multiple correlations being computed. A third variate was then added and all partial and multiple correlations for this group were computed. A fourth variate was then added, and so on. This analysis indicated the necessity for eliminating 2 of these 7 primary variates because they were found to be highly intercorrelated with some combination of the others. The variates thus rejected were (8) annual precipitation and (9) daily temperature range. At this point it may be of interest to note that the former analysis by the process of iteration indicated that these two variates had minor independent significance. If the iteration had been carried sufficiently beyond the 4 approximations actually computed, this would doubtless have resulted in definitely disclosing their lack of independent significance.

At this stage of the analysis, Series 2, 15, 16, 17, 18, 19, and 20, the 7 primary variates originally discarded because of their low simple correlations with the dependent variate, were again scrutinized by means of scatter diagrams and simple correlations with the residuals of the regression equation used in computing the multiple correlation, $r_{1.34567}$. The investigations confirmed the original judgment that they were non-significant, except in the case of (2), the series representing per cent of population colored, which showed distinct evidence of non-linear correlation with the residuals (see Figure I). The linear correlation between the residuals and per cent colored for the 9 southern states was — .671 and the correlation, over another range, for the 33 northern, western, and border states was + .710 (the two lines being used as an approximation to a cubic parabola). Linear correlations were then computed for each of the two ranges between (2) per cent of population colored and (1) the actual white tuberculosis death rate, resulting, for the 9 southern states, in a coefficient of — .657 and, for the 33 other states, a coefficient of + .614, thus indicating that the apparent significance of per cent colored could not be attributed to a residue of non-linear influences from variables (3) to (7). The significance of per cent colored was further explored in order to determine what part of the high values was contributed by Tennessee, Kentucky, and Arkansas, which form to some extent a mountaineer region. With these 3 states omitted, the correlations between per cent colored and the residuals were — .585 for 8 southern

[19] H. L. Rietz, *Handbook of Mathematical Statistics*, Boston, 1924, pp. 139–143.

FIGURE I

REGRESSION OF RESIDUALS ON PER CENT OF POPULATION COLORED


●=OBSERVED VALUES BY STATES
—=LEAST SQUARES LINEAR TREND
R = 1.440 X₂ — 4.682
R = — .678 X₂ + 18.823
TUBERCULOSIS DEATH RATE WITH EFFECTS OF SERIES 3 TO 7, INCLUSIVE, REMOVED
PER CENT OF POPULATION COLORED

states and + .548 for 31 other states. This clearly indicated significance independent of the effect of the 3 mountaineer states in question. As a matter of fact a reflection of the "hill-billy" influence was already provided for in large measure by 2 other of the 6 primary variates, namely (3) per cent illiterate, and (4) school expense, as well as by 2 variates rejected as showing no independent significance, namely (10) death rate from all causes and (17) per capita income. Inclusion of per cent colored in the regression equation had the effect of raising the multiple correlation coefficient to .915 from .796, the latter figure being the correlation derived from the 5 primary variates, series (3) to (7).

The 6 variable regression equation in question was obtained by (1) finding the regression of per cent colored with the residuals

$$R = X_1 - 4.083\,X_3 + .129\,X_4 - .628\,X_5 + 8.067\,X_6 + .00945\,X_7 - 70.714$$

on the two ranges consisting of 9 southern states and 33 other states (see Figure I), obtaining, respectively, the equations

$$R = -.678\,X_2 + 18.823,$$
$$R = 1.440\,X_2 - 4.682,$$

(2) defining a new series as a function of per cent colored as follows:

$Y_2 = -(0.678/1.440)\ X_2 + (23.505/1.440)$ for the 9 southern states,
$Y_2 = X_2$ for the 33 other states,

(3) calculating the regression

$$X_1 = \beta_{12 \cdot 3 \ldots 7}\ Y_2 + \beta_{13 \cdot 24 \ldots 7}\ X_3 + \ldots + \beta_{17 \cdot 23 \ldots 6}\ X_7 + \beta_{10 \cdot}$$

The partial and multiple correlation coefficients were calculated from the usual formulas.[20]

The calculated values of Y_2 for the 9 southern states were: Alabama —.50, Arkansas 4.12, Florida 2.42, Georgia —1.02, Louisiana —1.16, Mississippi —7.42, North Carolina 2.42, South Carolina —5.21, and Virginia 3.65.

The *a priori* basis for the significance of per cent colored, treated curvilinearly, is not entirely clear. It is quite understandable that in the 33 northern, western, and border states the white tuberculosis death rate is affected in direct proportion to the per cent of population colored, since the negroes, with their much higher tuberculosis death rate, should constitute a source of infection for the whites. In the 9 southern states with very large proportions of negroes, the segregation of races is known to be much stricter than in the north or west. The situation with regard to the southern states may be explained on the assumption that, in the south, the greater risk of infection for whites, due to the presence of greater proportions of negroes, is increasingly offset by the reduction in risk due to the segregation of the latter. Whatever the final explanation, the statistical evidence cannot be ignored. In this analysis the 6 intermediate states, Delaware, Kentucky, Maryland, Oklahoma, Tennessee, and West Virginia, might have been taken from the group of 33 and added to the southern group of 9 without seriously impairing the significance of the correlation.

Making use of the adjusted variate for the per cent of the population colored, the following final regression equation was secured:

$$\overline{X}_1 = 1.493\ Y_2 + 4.157\ X_3 - .114\ X_4 + .0202\ X_5 - 8.577\ X_6 - .00808\ X_7 + 100.547.$$

The percentages of the total variance in the tuberculosis death rate (white) attributable to the variates included in the regression equation are: Y_2, 29.6; X_3, 29.7; X_4, 13.0; X_5, 0.2; X_6, 22.8; and X_7, 4.7.

[20] Truman L. Kelley, *Statistical Method*, New York, 1923, pp. 298 and 301.

The multiple and partial correlation coefficients are:

Multiple correlation coefficient	Value	Partial correlation coefficient	Value
$r_{1.67}$	.613	$r_{12.34567}$	+.745
$r_{1.236}$	.896	$r_{13.24567}$	+.630
$r_{1.345}$	.740	$r_{14.23567}$	—.272
$r_{1.2345}$	.862	$r_{15.23467}$	+.005
$r_{1.34567}$	.796	$r_{16.23457}$	—.532
$r_{1.234567}$	.915	$r_{17.23456}$	—.122

Whenever (2) appears in a multiple or partial correlation it refers to Y_2, the derived series for per cent colored.

PROBABILITY TESTS

Some mention should be made of various tests of significance applied to the results. To begin with, in each case where the simple correlation coefficient between one of the 19 primary variates and the tuberculosis death rate was not practically zero, its sign turned out to be as expected on the basis of generally accepted *a priori* reasoning. These 19 simple correlation coefficients included such high ones (disregarding signs) as .680, .638, .591, .581, .520, .511, .477, .398, and .306. The probability of so high a correlation as .680 being obtained by chance in the absence of a real connection with tuberculosis, in a sample of 42 from a normally distributed population, is only 7.30×10^{-7}. This is so small as to leave no doubt of the existence of a genuine correlation. Even if we make allowance for the fact that this is the greatest correlation in the set, it is clearly significant. For if we call the foregoing probability P, and denote by P' the probability that the greatest of nineteen random correlations should be so great purely by chance, then

$$1 - P' = (1 - P)^{19};$$

whence, to a sufficient approximation, $P' = 19\,P = 1.39 \times 10^{-5}$, a result still so small as to be amply significant of the existence of a real relationship.[21] When the high correlations of 8 other variables

[21] The extremely small probabilities given above cannot be determined from R. A. Fisher's tables, *Statistical Methods for Research Workers*, 4th ed., 1932, page 188, but were calculated from the series, appropriate to even values of N,

$$P = \frac{(N-3)!\,(1-r^2)^{(N-2)/2}}{2^{N-4}\,[(\frac{1}{2}N-2)!]^2\,(N-2)r}\left\{1 - \frac{1-r^2}{Nr^2} + \frac{1\cdot 3\cdot(1-r^2)^2}{N(N+2)r^4} - \cdots\right\},$$

derived from the exact distribution by Harold Hotelling in a work not yet published. The series is in this case divergent, but a study of the remainder term shows that the terms given above supply an adequate approximation for the value of P given in the text.

are taken into consideration, the probability, even allowing for intercorrelations, is, of course, something less than 1.39×10^{-5}. Thus the hypothesis that none of the primary variates was correlated with tuberculosis was at once rendered untenable.

Of the 6 primary variates included in the final multiple correlation the following probabilities of obtaining, in the absence of a real effect, the partial correlations reported in the preceding table, have been computed from the R. A. Fisher table, page 188, *op. cit.*:

	r	N	P
$r_{12.34567}$	+.745	35	.000025
$r_{13.24567}$	+.630	35	.00015
$r_{14.23567}$	—.272	35	.1
$r_{15.23467}$	+.005	35	.98
$r_{16.23457}$	—.532	35	.0013
$r_{17.23456}$	—.122	35	.5

It will thus be seen that conclusive evidence of independent significance attaches to (2) per cent colored, (3) per cent illiterate, and (6) hours of sunshine, 9 chances in 10 to (4) school expense, and an even chance to (7) altitude. In the case of (5) occupational index, there is disclosed practically no evidence for an effect, and, since the simple correlation coefficient, r_{15}, was only +.274, there is little possibility that this variable is of substantial importance within the limits of the present study. However, the signs of the simple correlation coefficient, r_{15}, and of the partial coefficient, $r_{15 \cdot 23467}$, were both positive, as expected on the basis of *a priori* reasoning. Furthermore, the study *Death Rates by Occupation, op. cit.*, indicates that the tuberculosis death rate varies to a marked degree for different occupations. Because of these considerations it was decided to retain the occupational index as one of the 6 variables included in the final multiple correlation. The explanation of its apparently slight significance in the present study is probably that the distribution of the population by occupations does not, in general, vary to a marked degree from state to state. If the analysis could have been based upon smaller units, such as counties, it might then have been possible to establish this factor as conclusively important.

Apart from the independent significance reported above, certain of the series shared large elements of significance with other series. In this category were (7) altitude, (8) precipitation, (9) daily temperature range, (10) death rate from all causes, and (14) relative humidity. Since the simple correlation between each of these series and (1), the dependent variate, was higher than .5 (see Table II),

any one of them might conceivably represent more than 25 per cent of the "causes" of the variation in the tuberculosis death rate. They cannot, therefore, be dismissed as definitely unimportant, even though evidence of independent significance is slight or altogether lacking.

In estimating the significance of the various multiple correlation coefficients, the following values of the probabilities were found from Karl Pearson, *Tables of the Incompete Beta-Function,* London, 1934, page liv.

	R	*N*	*n*	*P*
$r_{1.67}$	.613	42	2	.000084
$r_{1.345}$	.740	42	3	.000001
$r_{1.34567}$	.796	42	5	.0000004
$r_{1.2345}$	.862	42	6	<.0000001
$r_{1.236}$	.896	42	5	<.0000001
$r_{1.234567}$	.915	42	8	<.0000001

The last 3 probabilities are less than the values recorded, for the reason that the tables end with 7 place accuracy. Because of the non-linear relationship between (2) per cent colored and the dependent variate, it was assumed that the former represented 3 primary variates, as if a third degree curve had been fitted to the series in question. Each of the 6 probabilities presented above constitutes conclusive evidence of real relationship.

In the various tests of probability, it was assumed that each variate represented 42 observations which, for the 2 death rate series, were a 3-year mean for the population of each of the 42 states and, in the case of climatic series, were based on weather records for a long period of years. However, the size of population or length of period covered had no bearing on the probabilities as computed. Obviously a given result is more conclusive when based on a 3-year record than when on a record of one year, and when based on 100 million people than when on a smaller number divided into the same 42 groups, since the larger the number of people included in the sample, and the longer the period covered (within reasonable limits), the smaller will be the random errors in the data. For a discussion of the relation of the length of time to the accuracy of an observation see C. F. Roos, *Dynamic Economics,* Bloomington, Indiana, 1934, Appendix II. In spite of the foregoing considerations, the probabilities of significance, as reported in this paper, have been computed according to what seems to be the best technique available and upon what is believed to be a very conservative basis.

It is not contended, of course, that any of these probability tests can afford conclusive evidence as to specific causes since there is always

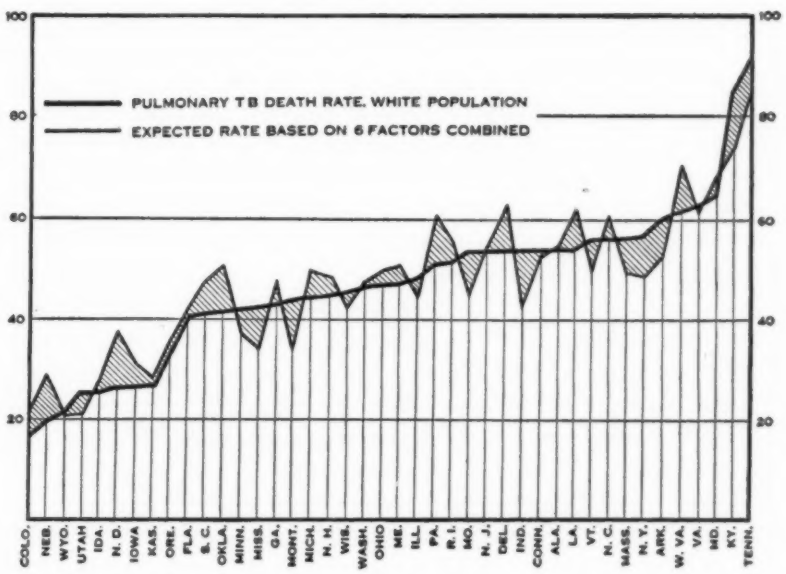
the possibility that the elements identified as apparently significant may simply be correlated highly with the true etiological factors. However, the conclusions are supported by *a priori* reasoning and, in the case of the partial correlations, none of the variates considered was omitted if it had an important effect on the independent significance as disclosed in the process of iteration. In the conclusion, the only variates rejected as definitely non-significant are those showing very low correlation with the dependent variate and with the residuals derived by eliminating the effect of the primary variates 2 to 7. In view of these considerations, it would seem reasonable to place a considerable degree of confidence in the conclusions given at the end of the paper.

THE RESULTS

The analysis indicates that 13 of the 19 factors examined are of no independent significance, but that the remaining 6 combine to reflect a major part of the variation in the tuberculosis death rate among the different states of the United States. That this is indeed the case is evident from an inspection of Figure II. The heavy curve, representing the observed tuberculosis death rate, is followed quite closely

FIGURE II

TUBERCULOSIS DEATH RATE (WHITE) AND EXPECTED RATE BASED ON 6 FACTOR REGRESSION EQUATION



by the light curve, representing the expected rate as constructed from the regression equation used to combine the 6 factors selected as being independently significant.

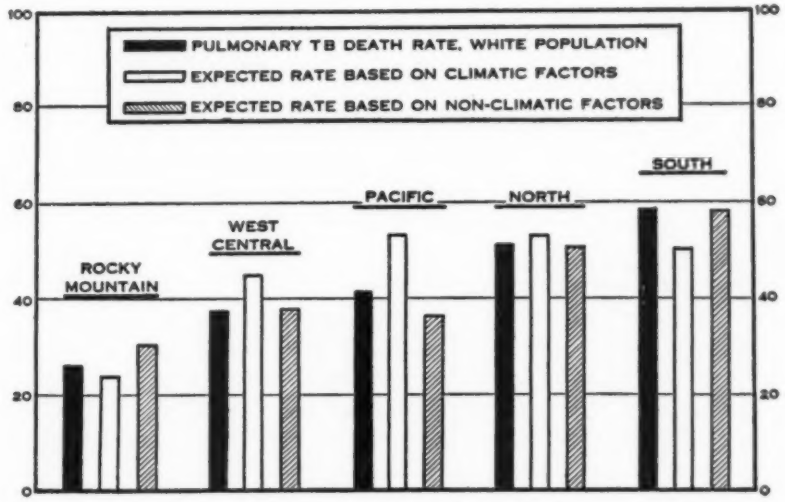
In view of the general belief that the prevalence of tuberculosis varies directly with population density and inversely with standards of living, it is of particular interest to note that non-climatic factors exhibiting independent significance were per cent of population colored and indicators of standards of education, chiefly per cent of white population illiterate and, to a lesser extent, expenditures on public elementary and secondary schools. A very slender possibility of independent significance attached to the occupational index and a substantial possibility of significance, which is not independent, to the death rate from all causes.

The results indicate that climatic factors are of independent significance, although less so than the non-climatic. Of the former, conclusive evidence of independent significance attaches to hours of sunshine. Climatic factors having a large possible element of importance divided, through intercorrelation, among other variates, include altitude, precipitation, daily temperature range, and relative humidity. Within the limits imposed by the present study, altitude assumes a significance almost identical with that of relative humidity, as indicated by the high correlation between these two variables reported in Table II. The reason for retaining altitude instead of relative humidity in the various multiple correlations is that the *a priori* basis for inclusion of the former is considerably more convincing than in the case of the latter. Altitude determines to a large extent the amount of actinic radiation which reaches the earth and it is also associated with certain physiological phenomena, as reflected in the differential blood count, which are probably dependent upon the oxygen content of the atmosphere. In the case of relative humidity the only *a priori* basis for significance is that it largely determines the rate of evaporation.

In Figure III the states have been combined into 5 geographical divisions, each of which represents fairly uniform conditions. The relative effect of climatic and non-climatic factors on the tuberculosis death rate is indicated by the white, shaded, and black bars. It will be seen that as the death rate, represented by the black bars, declines, the expected rate, as represented by the white and shaded bars, also declines in about the same proportion. The South, which has the highest death rate, also has the highest expected rate. The North has almost exactly the expected death rate. In the Pacific Northwest the death rate is apparently lowered by particularly favorable non-climatic factors below what would be expected from not especially

FIGURE III

TUBERCULOSIS DEATH RATE (WHITE) AND EXPECTED RATES BASED ON CLIMATIC AND NON-CLIMATIC FACTORS, BY REGIONS



favorable climatic conditions. The relatively low death rate for the West Central section is fairly well accounted for by relatively favorable conditions, both climatic and non-climatic. Since the non-climatic factors in the Rocky Mountain States are not appreciably more favorable than in the cases of the West Central and Pacific states, the remarkably low death rate for the sunny, dry, and high altitude Mountain States seems only to be explained satisfactorily on the basis of uniquely favorable climatic conditions.

From Table I have been computed the following averages for the 5 states with the lowest pulmonary tuberculosis death rate for the white population compared with the averages for the 5 states with the highest rate:

	Five states with lowest tuberculosis death rate (white)	Five states with highest tuberculosis death rate (white)
Tuberculosis death rate (white)	21.4	73.8
Hours of sunshine	8.2	6.9
Altitude in feet	4090	482
Relative humidity	59.2	75.4
Precipitation	17.7	43.5
Daily temperature range	24.2	18.5

CONCLUSION

A statistical study of more than 150,000 deaths from pulmonary tuberculosis among the white populations of 42 states in the United States, in relation to 19 elements of possible significance, resulted in the identification of 6 factors which combined to reflect a major part of the variation of the death rate among the different states.

1. The per cent of population colored appears to have a considerable direct relationship to the tuberculosis death rate for the white population in the case of 33 states with less than 19 per cent negroes. In the case of 9 southern states with more than 25 per cent negroes, a different relationship is indicated, which might be due to the fact that stricter segregation of the colored population is customary in these southern states than in states where less of a race problem exists. This evidence need not be construed as an argument for segregation of negroes since safeguarding them with sufficiently effective hygienic measures would accomplish adequate protection for the whites.

2. Educational factors, chiefly per cent of white population illiterate and, to a lesser extent, per capita expenditures in elementary and secondary schools, represent in total importance a large part of the elements disclosed as significant.

3. The remarkably low tuberculosis death rate for the Rocky Mountain states seems to be mainly accounted for on the basis of uniquely favorable climatic conditions. One factor which seems to be definitely significant is hours of sunshine. Other climatic elements of possible significance are precipitation, daily temperature range, and altitude, the significance of the last, within the limits imposed by the present study, being practically identical with that of relative humidity.

4. The analysis indicates that negligible significance attaches to standards of living as measured by per capita income, or to the degree of crowding in the extent to which it is represented by population per square mile and per cent of white population urban.

5. In so far as the states of the United States are concerned, high standards of education and minimizing the risk of infection from negroes, combined with life in a sunny, dry, and high altitude climate, would seem to be far more important than other elements, such as large per capita income or low population density, in reducing to a minimum the white death rate from pulmonary tuberculosis.

FLEXIBLE RAILWAY FREIGHT RATES [1]

By Julian S. Duncan, *St. John's College*

INTRODUCTION

This paper is a discussion of the problems arising from the fact that railway rate making takes place in an economic environment of a fluctuating price level and changing rates of business activity.[2] Recent writers on business cycles have stressed the significance of the frictions resulting from differing rates of price change. Freight charges respond slowly to other price changes and they represent an important element of business costs, especially in the construction industry. It is difficult, of course, to establish any definite connection between freight rates and the movements of the business cycle. The importance of the question, however, justifies an examination of the available evidence.[3] What is written here is not offered as the final word but as a stimulus to further investigation and discussion.

The revenue per ton mile figure of the Interstate Commerce Commission is, despite drawbacks, the best available measure of the level of freight rates. Freight charges, Chart I shows, lag behind general price movements both when prices are rising and falling.[4] The index of freight rates on wheat and the index of the farm price of wheat, both prepared by the Bureau of Agricultural Economics, were 101 and 234 respectively in 1917, 146 and 44 in 1932. The corresponding index of freight rates on livestock and the index of farm prices of meat animals were 103 and 192 respectively in 1917, 60 and 156 in 1932.[5] Stated in terms of purchasing power, for example, this means that railway rates have been increasing since 1929. It would be futile to try to measure the exact extent of the lag. The making of the final decision about the level of rates is in the hands of the Interstate Commerce Commission. The speed of adjustment to changes in the price level varies.

[1] I am under heavy obligation in the preparation of this paper to Professor John Maurice Clark of Columbia University, Dr. Charles O. Hardy of the Brookings Institution, Dr. Max O. Lorenz and Mr. M. T. Corcoran of the Interstate Commerce Commission, and Mr. Thor Hultgren of the Bureau of Agricultural Economics.

[2] This aspect of rate theory has received less attention than has been given to explaining rate differentials. See D. Philip Locklin, "The Literature of Railway Rate Theory," *Quarterly Journal of Economics*, Vol. XLVII, February 1933, p. 168.

[3] See Chelcie C. Bosland, "Flexible Utility Rates", *Journal of Land and Public Utility Economics*, Vol. X, May 1934, for a study of this problem with special reference to utilities.

[4] The rates for the period 1911–1934 are for Class I railroads. The wholesale price index is the All Commodity Index of the Bureau of Labor Statistics.

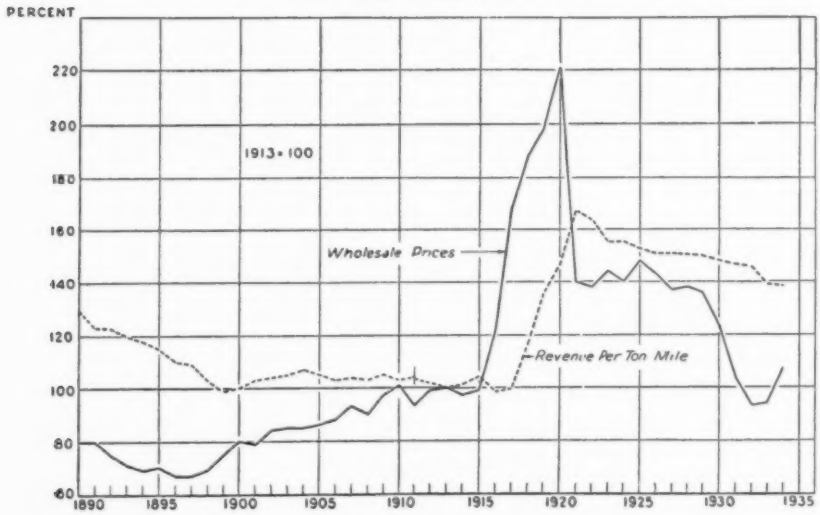
[5] There is a slight inaccuracy in comparing these indices because the freight rates indices are based on 1913 as 100, while the farm price index of wheat is based on 1909–1913 as 100, and the farm price index of meat animals is based on 1909–1914 as 100. The difference, however, is so small that it does not affect its value for our purpose.

FACTORS MAKING FOR INFLEXIBILITY OF RATES

Five factors contribute to the lack of close correlation between the movements of commodity prices and freight rates. The first is that the regulatory process prevents quick adjustments of rates to the price level, since rates proposed by the carriers are subject to suspension and investigation by the Commission, in which case an opportunity may be granted for all interested parties to present evidence against the proposed change. This procedure spread over the vast number of classifications comprised in the rate structure, might take years. Administrative restrictions compel, therefore, resort to blanket increases or

CHART I

RELATIVES OF FREIGHT REVENUE PER TON MILE AND INDEX OF WHOLESALE PRICES



decreases.[6] Theoretically it may be a question whether it is ever proper procedure for a rate-making body to raise or lower tariffs by the same percentage for all classifications.[7] The ups and downs of business activity do not affect every industry in the same way, and it may be very unjust to apply blanket increases or decreases, but under the present law there is no practicable alternative.

A second factor which tends to make the railways resist decreases in rates during times of depression is that expenses do not decrease

[6] Interstate Commerce Act. Section 15, paragraph 7, 36 U. S. Stat. at Large, 552.

[7] See the argument of Professor Roland Vaile in the *Quarterly Journal of Economics*, Vol. XXXVI, No. 4, p. 719.

proportionately with the decrease in traffic which accompanies a depression. The power of the railway labor unions, also, is such that wage rates respond slowly to general price changes. There was no cut, for example, in the wages of railway employees until January 31, 1932, at which time a 10 per cent reduction went into effect. The unions were able to secure an agreement on April 26, 1934, for the gradual restoration of this cut, the last restoration taking place April 1, 1935.[8] Taxes, again, do not vary with commodity price changes. The high percentage of bonds in the capital structure of the railways makes them particularly vulnerable to changes in the volume traffic. Moreover, the secular trend of the ratio of funded debt to net capitalization has been upward, moving from 54.5 per cent in 1890 to 61.9 in 1933.[9]

A third factor making difficult the adjustment of rates to changing conditions is the existence of an excess of railway facilities on which the companies seek to earn a return, even in times of depression. There were too many railways even before competing means of transportation became an important factor. Total railway mileage has declined since 1916.[10] Mr. E. S. Butler has found that approximately 24 per cent of the total mileage of Class I Railways for the years 1919–1928, had traffic densities under 250,000 ton miles per mile of line per year.[11]

Higher rates would probably retard the movement of traffic less in the expansion and prosperity phases of the business cycle and lower rates might increase traffic in the contraction and depression phases. A reserve accumulated in the expansion and prosperity phases could be used to finance the railroads in periods of low income caused by either decreased rates or smaller volume of business.[12] The recapture provisions of the 1920 Transportation Act would have impeded attempts to use excess earnings of prosperous years to tide over poor years, since one-half the excess earnings of any year were recaptured by the government. It is not probable, however, that the recapture provision had any effect on rate adjustments. The new law, by im-

[8] See Chicago Wage Agreement, January 31, 1932 and appendices.

[9] Computed from data in *Statistics of Railways in the United States 1924 and 1932* Statement 53. The sharp increase in the floating debt of the railways forms no inconsiderable part of present fixed charges of the lines. The loans and bills payable of Class I Railroads were 71 million dollars in 1929; in April of 1935 this figure plus advances of the Reconstruction Finance Corporation and the Public Works Administration totaled 858 million. See *Statistics of Railways in the United States, 1929, 1933*, Statement 42, and reports of the Reconstruction Finance Corporation.

[10] *Statistics of Railways in the United States, 1931*, Statement 53.

[11] Cited by Dr. Wilfred Eldred in Harold G. Moulton and Associates, *The American Transportation Problem*, Washington, 1933, p. 156.

[12] See Report of the Joint Commission of Agricultural Inquiry, 67 Cong., 1st Ses., House Document No. 408, Pt. 3, p. 3 and the testimony of Secretary Wallace before the Interstate Commerce Commission, December 7, 1934, Ex parte No. 115, Transcript of Testimony, p. 6247.

plication, appears to recognize the necessity of allowing the railroads to accumulate reserves in good times to tide them over bad times. It states:

> In the exercise of its power to prescribe just and reasonable rates the Commission shall give due consideration, among other factors to the *effect of rates on the movement of traffic;* to the need, in the public interest, of adequate and efficient railroad transportation at the lowest cost consistent with the furnishing of such service; and to the need of revenues sufficient to enable the carriers, under honest, economical and efficient management to provide such service.[13]

The form in which depression reserves should be accumulated is, of course, a question. If the reserve be in securities it might be difficult to market them. If the reserve were used to pay off debts it might be impossible to reborrow. The remedy here could be a government financial organization like the Reconstruction Finance Corporation. The reserve might also take the form of expenditures for maintenance and improvements in times of prosperity. This would make possible temporarily a sharp curtailment of upkeep outlays in periods of low earnings. But there is a limit to the length of time maintenance work can be deferred. Even if it be assumed that business will soon attain the 1929 level it is not likely that the railroads will handle the same proportion of the traffic as before. The competitive strength of other forms of transportation points to the need of a scaling down of the funded debt of many lines.[14] If the contraction reaches such a point that the reserves could pay off the major part of the remainder in periods of high earnings, then it should not be hard for the lines to reestablish the debt during low earning periods. The form in which the reserves are accumulated ought to harmonize with any scheme of social insurance reserves adopted by the Federal and State governments.

FREIGHT RATES AND OTHER PRICES

The preceding has been an enumeration of the factors which hinder the prompt adjustment of freight charges to changes in the level of prices. The relation of this lack of correlation with the movements of the business cycle is the concern of the third part of this inquiry. An important problem is the effect of areas of rigid prices on general price movements and business fluctuations. There seems to be general

[13] Emergency Railroad Transportation Act, 1933, 48 U. S. Stat. at Large, 211, Sec. 205, Paragraph 2. (Italics mine.)

[14] The railroads, indeed, may not remain in private hands unless the debts are reduced. Assuming in such event that private enterprise be retained for other industries, government owned lines should adopt a flexible rate policy and depression reserves.

agreement that the existence of inflexible prices tends to retard business activity in a price system in which other prices are subject to violent changes. But there is no way, on the basis of data now available, to measure the degree of friction.[15]

An interesting phase of this question is whether or not inflexible prices make other price changes more violent. Methods have been developed for measuring the relative degree of price stability in different price series. Professor Frederick C. Mills, for example, has constructed an index of instability and developed measurements of the monthly variability of prices and of the frequency of price changes of raw materials and manufactured goods.[16] He found that the prices of raw materials were less stable than the prices of manufactured goods.

Now freight charges are a larger percentage of the value at destination of raw materials than of manufactured goods. This is shown in two recent studies of the Interstate Commerce Commission, the conclusions of which are summarized in the following table:

Per Cent Freight Revenue is of Value at Destination [17]

	Commodity Groups	1928	1930
I	Products of Agriculture	10.01	11.53
II	Animals and Products	2.93	3.56
III	Products of Mines	21.30	45.75
IV	Products of Forests	12.96	18.26
V	Manufactures and Miscellaneous	3.04	4.02
VI	All L.C.L. Freight	6.94	4.12
	All Freight	7.08	6.67

The prices at the place of production should show greater variability than prices at market if inflexible transportation costs are an important element in the greater variability of raw material prices. Delivered and point of production prices are, however, only available for agricultural products and coal. A comparison of farm and market prices of agricultural products for the period 1910–1934, as shown in the next table, does not lend much support to the theory that freight rates play a significant role in the fluctuations of agricultural prices. The coefficients of variation are 34.5 and 31.3 per cent respectively.

[15] See for example: Frederick C. Mills, *Economic Tendencies in the United States*, National Bureau of Economic Research, New York, 1932, p. 311, and testimony of Dr. L. H. Bean before I.C.C., Docket 26,000, May 1933, Transcript of Testimony, p. 2201.

[16] *Economic Tendencies in the United States*, pp. 58, 63, 207, 339.

[17] These figures are total freight revenue for each commodity group expressed as percentages of total estimated value at destination. There is, as Dr. Max O. Lorenz, Director of Statistics, points out in his introduction, no correction for varying lengths of haul. Data are not available for making this correction. See Freight Revenue and Value of Commodities Transported on Class I Steam Railways in the United States," Calendar Year, 1928, *ibid.*, Calendar Year, 1930, Statement Nos. 29, 111, 3242, File No. 18-C-23. Similar studies, unfortunately, are not available for additional years.

Variation between Farm Prices and Market Price of Agricultural Products [18]
(1909–1914 = 100)

Year	Farm	Market	Year	Farm	Market
1910	102	104	1923	142	138
1911	95	94	1924	143	140
1912	100	102	1925	156	154
1913	101	100	1926	145	140
1914	101	100	1927	139	139
1915	98	100	1928	149	149
1916	118	118	1929	146	147
1917	175	181	1930	126	124
1918	202	208	1931	87	91
1919	213	221	1932	65	68
1920	211	211	1933	70	72
1921	125	124	1934	90	92
1922	132	132			

Mine prices of coal for the period since 1926, as given in the next table, have declined more than delivered prices, the coefficients of variation being 22.8 and 13.6 per cent. The fact that freight charges are a larger element in the delivered prices of coal than of farm products leads us to expect that there will be less correlation between its point of production and delivered prices.

Mine and Delivered Price of Bituminous Coal [19]
(1926 = 100)

Year	Mine	Delivered	Year	Mine	Delivered
1922	141.2	113.1	1928	90.6	93.6
1923	130.9	113.4	1929	86.4	91.3
1924	106.8	99.7	1930	82.5	89.4
1925	99.0	96.5	1931	63.6	84.6
1926	100.0	100.0	1932	74.7	82.0
1927	96.6	100.3	1933	65.0	82.8

Available figures do not, of course, establish conclusively that inflexible freight rates accentuate fluctuations in other prices. But they lend a measure of confirmation and nowhere contradict the hypothesis arrived at by a prior reasoning. The further development of statistical data would probably strengthen the case. If the position of this paper that the level of freight rates should be flexible be accepted, it follows that consideration should be given to the development of more statistical series showing the effects of freight rates on prices. The Bureau of Agricultural Economics, for example, prepares studies of the effects of freight rates on farm prices for use at hearings before the

[18] The index of farm prices is prepared by the Bureau of Agricultural Economics and the market price index is from the Bureau of Labor Statistics.

[19] The index of mine prices was compiled from the average mine price issued by the Bureau of Mines and the delivered price is the composite price index of the Bureau of Labor Statistics. Labor controversies and car shortages may, however, cause differences in the rate of variation. The spread, for example, between mine and delivered prices in 1922–1923 was due to the protracted coal strike of 1922.

Interstate Commerce Commission. Administration of a flexible rate policy would require that this and similar data be available in a continuous series. The writer suggests that the preparation of additional statistical data might proceed along three lines; first, the Interstate Commerce Commission and other government agencies could keep up to date the studies which were made in 1928 and 1930 of the relation of freight rates to value at destination of commodities, especially those the earlier investigations showed to have a high percentage of their value at destination represented by freight rates; second, increase of indices showing value at point of production and at market, like for example, the farm products price indices; third, a few more indices of freight rates on important individual commodities like those issued by the Bureau of Agricultural Economics on wheat, cotton, and livestock. Indices of freight rates on building materials should prove useful.

Another aspect of the disparity between freight rates and other prices is the extent to which the disproportion between freight rates and other prices affects business activity in the expansion and prosperity phases of the cycle. More specifically, does the fact that freight rates lag behind other prices in these phases make for what is called the overdevelopment of productive capacity? The entrepreneur will naturally be stimulated to increase his productive capacity if an important section of his costs remains constant while the selling price of his product advances. But it is not possible to say just how great this effect is. The overdevelopment of agricultural capacity in the World War period, for example, was clearly more influenced by other factors.

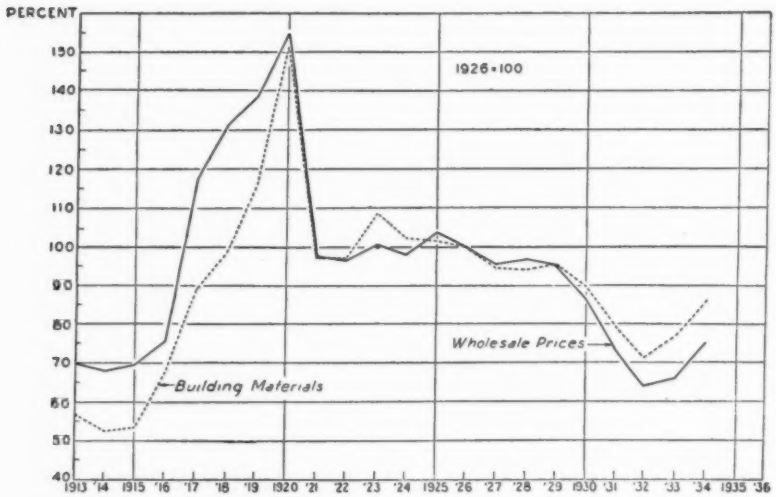
Still another phase of the relation of freight rates to business cycles is whether high freight rates, that is to say high in relation to other prices, retard the revival of the construction industry. There is a large measure of agreement that construction plays a vital role in the passage from depression to revival. Professor John Maurice Clark has recently pointed out the leading part carried by residential construction in such upswings.[20] Evidence showing that cycles in residential construction are of much longer duration and greater amplitude than the ordinary cyclical fluctuations in business activity does not make less necessary the revival of residential construction. The recent figures on residential construction released by the Bureau of Labor Statistics show some improvement but the latest available figure, March 1935, is only 11.4 per cent of the 1929 average.[21]

[20] John Maurice Clark, *Strategic Factors in Business Cycles*, National Bureau of Economic Research, New York, 1934, p. 33.

[21] See John R. Riggleman, "Building Cycles in the United States, 1875–1932" this JOURNAL, June 1933, p. 133, and Arthur F. Burns, "Long Cycles in Residential Construction," in *Economic Essays in Honor of Wesley Clair Mitchell*, New York, 1934, p. 67.

CHART II

INDEX OF BUILDING MATERIALS PRICES COMPARED WITH INDEX OF WHOLESALE PRICES



Building material prices, as Chart II shows, are now higher than the all-commodity index. A substantial proportion of the building materials comprised in the index are those having a high percentage of their delivered costs represented by freight rates. Furthermore, studies of the Bureau of Labor Statistics show that materials, as a part of the cost of construction, have increased from 58 per cent in 1928 to 63.6 per cent in 1932. This higher percentage probably still holds today. These facts seem to indicate that freight rates may be a factor affecting the more complete revival of the building industry.[22] The housing bill seems to recognize by implication that freight rates on building materials may be retarding the expansion of construction.[23] The Federal Housing Administration has not, however, made any move towards a reduction of freight rates on building materials.

THE ATTITUDE OF THE INTERSTATE COMMERCE COMMISSION AND THE COURTS

The considerations above presented afford a basis for the discussion of certain positions taken in the most recent interstate Commerce Commission decisions involving the relation of the level of rates to other prices. The 1933 petition of the associations representing agri-

[22] There are regional differences in the extent to which the building industry utilizes railroad transportation. Regional differences probably exist in the degree of stagnation of the construction industry but data are not available to say whether freight rates cause them.

[23] National Housing Act, No. 479, 73d Cong. 2nd Ses. Title V, Sec. 511.

culture, coal mining, lumber manufacturers, owners of sand and gravel pits, and crushed stone quarries asking for a reduction in the general level of rates was denied.[24]

The rates especially at issue in this case were those on that part of the traffic which appears to be relatively immune from the competition of other types of carriers. It was not disputed that the railroads were reducing rates which are subject to motor and other types of competing carriers. It was further admitted that even after allowing for the upturn in prices, freight rates were out of line with other prices. The Commission, that is the majority, did not believe that much increase in total traffic would result from lowered rates. Their view was that the net movement of goods in the country would not be augmented. The railroads might gain some traffic from competing carriers but this increase probably would not offset the decline in rates. General business activity, the Commission concluded, would not be stimulated.[25]

Whether or not 1933 rates could be called reasonable in the meaning of the Interstate Commerce Act depends on the emphasis given to the cost of service principle. The rates are unreasonable if the same weight is given to this theory as has been given in other decisions since 1910. Obviously it will take more stress on the cost of service theory to justify 1933 rates than, for example, the rates of 1926. The relative of revenue per ton mile for 1933, taking 1926 as 100, is 91.1; the wholesale price index for 1933, likewise with 1926 as 100, is 65.9. This means that the part of the traffic assumed to be safe from competing forms of transportation must, as Commissioner Aitchison points out in the minority opinion, support rates high enough to carry the entire railroad overhead. This is stretching the cost of service principle beyond its proper limit. The value of service concept can not be relegated to a minor role, it would seem, without changing the law.

One may accept the contention of the majority of the Commission in the 1933 decision that the railway transportation machine must be preserved without agreeing that keeping rates up is the best method of doing it. The shipper might urge that taxation is a more equitable method of making up the difference between what the traffic ought to bear and the expenses of the railroads. It is also open to debate whether the preservation intact of the existing capital structure of the railroads is the only or even the best way of saving them. Alternative means, even government ownership, would seem preferable to

[24] It is beyond the scope of this paper to go into an analysis of all the I.C.C. cases involving the level of rates and the general price level.

[25] General Rate Level Investigation, 1933, No. 26,000, 195 I. C. C. 5.

allowing inflexible rates to be a brake on economic activity. A third question on which the position of the majority of the Commission is inconclusive is whether lower rates might not produce more net revenue.

The minority of the Commission declared for a 10 per cent reduction from the maxima of 1922. This reduction would have applied chiefly to freight which has suffered least from the competition of other forms of transport. The railways themselves have been and are reducing tariffs on the competitive traffic. A striking illustration of this is cotton. The Bureau of Agricultural Economics index of freight rates on cotton (1913–100) declined from 163 in 1929 to 98 in 1933. Livestock is an equally vivid illustration of rates which have not changed, the index (1913–100) being 155 in 1929 and 156 in 1933. The rates already cut 10 per cent or more were not to be affected. The lowering of rates advocated by the minority would have been an important step towards bringing freight rates into line with other prices.

It must be noted, in considering the majority view, that from the time the Commission opened hearings in April 1933, until the decision was announced in late July, the index of wholesale prices rose from 60.4 to 68.9. Many citizens believed that by the use of inflationary and other measures prices might be brought back to the 1926 level.[26] There was obviously more justification for refusing to grant a reduction in rates after the accession of an administration which had declared its intention of using every possible means, including monetary manipulation, of raising prices. The preceding administration showed no similar determination to arrest the fall of commodity prices and therefore the acceptance of the theory of flexible rates would have called for a consideration of a reduction of rates prior to 1933. A flexible rate policy would have precluded the 1931 increase in rates. Price disparities by 1931 had, on the contrary, become sufficiently marked for a consideration by the Commission of rate reductions.

In August of 1934 the railroads joined in a petition to the Interstate Commerce Commission asking for emergency increases of approximately 10 per cent in freight charges.[27] The Commission did not accept the proposals of the carriers but approved a substitute plan framed by it for temporary surcharges averaging 5 per cent to remain in force until June 30, 1936.[28] Four of the nine members

[26] See Mordecai Ezekiel, "Evaluating 1933 for the Farmer," this JOURNAL, Vol. XXIX, June 1934, pp. 143–144.

[27] 208 I.C.C. Ex Parte No. 115, decided March 26, 1935. Subsequent page references are to the temporary booklet giving the text of the decision.

[28] *Ibid.* p. 60.

opposed any upward revision. Commodities on which surcharges were authorized included: (1) construction materials such as stone, gravel, sand, cement, brick, millwork, iron and steel; (2) raw materials such as coal, petroleum, and iron ore.[29]

The contention of this paper is that the chief criteria for changes in the level of rates should be the movements of the commodity price level and the rate of business activity. Prices were in a downward spiral in 1931 when emergency charges were allowed; now the fall in prices has been arrested and the price trend has been upward since March 1933. There is, therefore, more excuse for a raise now than in 1931. But it may be doubted if recovery and particularly the revival of the construction industry had progressed far enough for the adding of surcharges. The competing methods of transportation, of course, make it doubtful whether the increases granted will increase the revenue of the lines.[30] The authorized surcharges do not touch the basic factors of economies through consolidations and pooling of facilities and equipment, provision of new services to meet competition, adaptation of rate structures to changed conditions or reforms in capital structure through financial reorganization.

The decision of the Supreme Court in the Maryland telephone case, delivered June 2, 1935 suggests that legislation looking toward more flexible rates would have to be carefully drawn to avoid being declared unconstitutional. The rates in question in this case were wholly intrastate but the questions considered throw light on the courts' possible attitude toward flexible rates. The Public Service Commission of the state of Maryland applied a composite price index to the 1923 rate base and subsequent additions to company plant in order to arrive at present valuation.[31] Commodity, construction, Western Electric Company prices for telephone equipment, Baltimore wages, and other indices were combined and weighted for the purpose of providing a "translator" into present (1933) value. The majority of the Court held that the price indices used were not prepared for use in the appraisal of property and they questioned the soundness of the Commission's method of weighting. They feared especially that valuation would be too much affected by sudden shifts in the

[29] *Ibid.* pp. 81–82.

[30] See the opinions of Chairman Tate, Commissioners Aitchison, Porter, and Miller, *ibid.*, pp. 63–76.

[31] Public Service Commission of Maryland vs. Chesapeake and Potomac Telephone Company of Baltimore City. The majority opinion was delivered by Mr. Justice Roberts. A dissenting opinion was pronounced by Mr. Justice Stone, speaking for himself, Mr. Justice Brandeis, and Mr. Justice Cardozo.

price level. They admitted, however, that valuations must take into account changes in the prive level.[32]

Decisions of fact of the Interstate Commerce Commission are not reviewable by the courts but it is probable that the important issues which more flexible rates present would find their way to the Supreme Court. If that Court choose to exercise its power of review the delays inevitable in the judicial process could make such a policy unworkable. More than two years, for example, elapsed between the time the Maryland Public Service Commission began its inquiry and the delivery of the Court's opinion. Those who favor planned efforts to control economic activity will be inclined to question the desirability of judicial nullification of legislative experiments.

Two things would impede the functioning of the Interstate Commerce Commission as the agency through which a policy of flexible railway rates could be translated: first, the heavy burden of complicated routine decisions leave the members too little time for any study, not specifically connected with pending cases, of the relation of freight rates to prices and business activity; second, the Interstate Commerce Act does not explicitly state that the Commission is to act as an economic as well as a judicial body. Adoption of a flexible rate policy would depend on the removal of these obstacles. And provisions looking to closer correlation between rates and other price movements are only part of the program needed for coping with cyclical fluctuations. The work of the Commission in effectuating such a rate policy would logically be coordinated with the activities of some equivalent of a national planning board.

[32] Statisticians will be interested in reading Mr. Justice Stone's closely reasoned defense of the use of statistical methods in settling rate controversies.

TEST CRITERIA FOR STATISTICAL HYPOTHESES INVOLVING SEVERAL VARIABLES*

By S. S. Wilks, *Princeton University*

INTRODUCTION

Most of the tools and devices now used in statistical inference have sprung from the study of problems involving a single variable. They are designed so as to be applicable to a series of measurements of a single trait or attribute exhibited by individuals in certain homogeneous or rational classes of objects. Even in problems in which several traits of such individuals are measured, the usual procedure in applying the principles of statistical inference is to consider the traits separately. Such a study consists of describing each trait, ordinarily by means of frequency functions, and making certain hypotheses about each trait and testing the tenability of the hypotheses by means of probability theory. This procedure is unquestionably justified if all that is required is a trait-by-trait analysis of the data. However, it is becoming more and more evident, in the study of sociological and economic problems particularly, that, of the information furnished by a multivariate set of data, an enormous amount may be contained in the interrelationships among the variables. Examination of multivariate data and efficient testing of hypotheses relating to several variables require the use of multivariate methods. Such criteria as the multiple and partial correlation coefficients, path coefficients and the method of the analysis of variance and covariance are used extensively on multivariate data, but there are problems in which hypotheses arise which cannot be adequately tested by these criteria.

The weakness of the usual method of handling several statistical variables occurs in significance tests rather than in the description of the data. This inadequacy appears to be rather significant in view of the requirement that to be as scientific as possible, a statement as to how well a set of observations conform to a certain hypothesis should be accompanied by some measure of its credibility. It is difficult to point to any problem involving inferences to be drawn from a sample in which the statistical analysis can be complete without some kind of a test of significance of agreement between observation and hypothesis. Significance tests are essential for statistical

* A revised form of the paper entitled, "The Sampling Theory of Several Variables," presented to the American Statistical Association, December 27, 1934.

inference. Without going into the technical aspects [1] of the problem of constructing criteria for making significance tests, we estimate the credibility to be placed in the departure of a set of observations from expectation, as based on some hypothesis, as follows: (1) we find a function which measures jointly the departure of all observed measurements from their expected values and identify the values which this function can assume with degrees of tenability of the hypothesis; (2) assuming the hypothesis true, we find the probability that the function will take one of a set of values more unfavorable to the hypothesis than that actually observed; (3) if this probability is sufficiently small, we reject the hypothesis as false; if it is sufficiently near unity, we accept the hypothesis. If the probability is neither near unity nor zero, we may prefer to remain in doubt until more evidence is collected.

In order to be more concrete we shall consider several situations involving multivariate data in which statistical tools of more general nature than those now used would be valuable. Suppose we have measurements of each of several cranial attributes (e.g., length, breadth, etc.) from a set of male skulls discovered in a certain section of Panama. It may be of anthropological interest to know if this set of skulls differs significantly from that of the Mayan Indians farther north, whose characteristics, we shall suppose, are known with great precision. How shall we test for the agreement between the newly discovered set of skulls and that of the Mayans? If we use single-variable methods on the mean and variance of each attribute and on each correlation coefficient between pairs of traits we may find certain means, variances and correlations significant and others non-significant. When the evidence appears to be divided among the means, variances and correlations in this manner, it is very difficult without some comprehensive criterion to say whether the Panama skulls are really different from the Mayan ones.

It is this "split-evidence" type of difficulty that lead to the development of the χ^2 test of goodness of fit. The thing that was needed was a criterion for taking into account a number of normally distributed discrepancies simultaneously and determining how the aggregate of discrepancies, as measured by the criterion, would behave from sample to sample even though some of the individual deviations might differ incredibly from their hypothetical values. For similar reasons a comprehensive criterion and its probability theory are needed in the skull problem for taking into account simultaneously the dis-

[1] For a thorough discussion of this point see J. Neyman and E. S. Pearson, *Phil. Trans. Roy. Soc.*, Ser. A, Vol. 231 (1932) pp. 289–337.

crepancies of means, variances and covariances from the Mayan values. As a variation of the foregoing problem, suppose a set of skulls from each of two neighboring regions is measured with respect to the several attributes and let us question whether the two sets of skulls belong to different races of people. We are not interested in any hypothetical values of the means, variances and covariances; we only want to know whether the two sets of skulls can reasonably be supposed to have come from the same race of people.

Let us consider an example in the application of statistical methods in industry. Shewhart [2] has essentially defined the state of control of the quality of a manufactured product with respect to a certain attribute by requiring that samples of the product be such that measurements of this attribute in the samples can be regarded with a high degree of probability as having been drawn from a population of values of the attribute, characterized by parameters having certain standard values. His methods have been developed primarily for the case in which quality is characterized by one attribute. However, there are circumstances under which it appears that quality should be characterized by several attributes. For example, the quality of a relay may be specified by capacity, inductance and resistance. The quality of certain aluminum die-castings may be characterized by tensile strength and hardness. In order to keep a check on the quality of relays, suppose a sample of them is drawn in the course of routine production. If the standards have already been set up for capacity, inductance and resistance we may proceed to use single-variable methods and test for control in each attribute separately. If lack of control is detected in any of the three attributes, the source of trouble must be sought. However, if all three are found to be under control we have gone through the trouble of making three tests. If we use a single comprehensive test only a single testing is needed. If the comprehensive test shows lack of control, then we must proceed to find the cause by applying tests to the variables separately. In spite of the possibility of discovering lack of control there does not appear to be much disadvantage in applying a comprehensive test first, because lack of control in well regulated production is the exception rather than the rule. In the case of aluminum die-castings hardness is often used to predict tensile strength, since an actual test of tensile strength is destructive. Therefore the stability of the covariance between tensile strength and hardness is very essential in addition to a controlled state of hardness and strength taken individually. It

[2] W. A. Shewhart, *Economic Control of Quality of Manufactured Product*, D. Van Nostrand Co., 1931, pp. 144–149.

appears here that a comprehensive test of stability of means, variances and the covariance would be useful.

In problems in replicated experiments in agriculture there may be an advantage in applying the analysis of variance for two variables to the problem of determining, in Latin square lay-outs for example, the effect of certain fertilizers on the yield of grain and straw from a certain cereal after the effect of heterogeneity of soil fertility has been removed by analysis of variance methods. If the comprehensive analysis of variance test shows lack of effect of fertilizers, then it will be unnecessary to test for effect on either grain or straw. If a joint effect is demonstrated, single-variable methods can then be used for making a detailed study of the effect on yield of grain and straw separately.

Finally, let us consider an example in mental testing. Suppose tests have been designed to measure the following four [3] traits: (1) arithmetic speed, (2) arithmetic power, (3) reading speed, (4) reading power. It may be desired to fit what is known as a factor pattern to these four traits. If the cross-correlations between the first two traits and the last two are fairly close to zero, it might appear that the arithmetic traits are independent of the reading traits and hence a factor pattern should not involve a common factor for the two sets of traits. But how shall we make a test of the independence of the two sets of traits? We again run into the possibility of divided evidence if we attempt to test the significance of the deviations of the cross correlations from zero individually. A general criterion would clearly be useful here. This type of example can readily be extended to include any number of sets of traits, in which case the question will arise: Can these sets be regarded as mutually independent?

Similar questions arise in social and economic problems. On account of the difficulty or impossibility of controlling factors in a study of social or economic phenomena it appears necessary to describe an event or situation by means of several variables. Such examples can be produced indefinitely in the various fields of investigation in which statistical methods are used.

The main purpose of this paper is to discuss, without going into technical details, criteria and significance tests appropriate for certain hypotheses which arise when handling several variables. We shall make the usual simplifying assumption of normality of the distribution of the variates, simply remarking that for non-normal dis-

[3] *Cf.* T. L. Kelley, *Crossroads in the Mind of Man*, Stanford University Press, 1928, p. 114.

tributions satisfying certain general conditions [4] the results which we shall consider will hold approximately for large samples.

CRITERIA AND SIGNIFICANCE TESTS FOR VARIOUS HYPOTHESES

1. Hypothesis that a sample is from a normal population with a specified set of means.

Let X_i $(i = 1, 2, \ldots n)$ be normally distributed variates. The population value of the mean and variance of X_i will be denoted by m_i and α_{ii}, the covariance between X_i and X_j will be α_{ij} $(i \neq j)$. In the usual notation α_{ij} is $\rho_{ij}\sigma_i\sigma_j$, where ρ_{ij} is the population value of the correlation coefficient between X_i and X_j and σ_i is the standard deviation of X_i. Let a sample of N individuals be drawn at random from this population. The sample values of α_{ij} and m_i will be a_{ij} and $\overline{X}_i$ respectively. In the present hypothesis we wish to be able to say whether or not the $\overline{X}$'s differ significantly from their true values m_i, whatever values the α_{ij} may have. We must therefore devise a criterion for measuring the joint departure of the $\overline{X}_i$ from the m_i which is independent of the α_{ij} and find its probability function assuming that the population values of the means are m_i. The criterion [5] which we shall consider is

$$Y = \frac{|a_{ij}|}{|a_{ij} + (\overline{X}_i - m_i)(\overline{X}_j - m_j)|}. \tag{1}$$

The quantity $|a_{ij}|$ may be termed a generalized variance of the sample with elements having $N-1$ degrees of freedom. The determinant in the denominator will be a generalized variance with elements having N degrees of freedom.

Y is a criterion of the Neyman-Pearson λ-type [6] which can be found by applying maximum likelihood principles. It can vary from zero to unity and will be unity when and only when all of the differences $\overline{X}_i - m_i$ are zero. In other words it will be unity only when the sample supports the hypothesis perfectly. As Y tends to zero the hypothesis becomes more and more untenable. When the true means are m_i then Y is distributed according to a Type I curve, and a significance test can be made from the tables of the Incomplete Beta Function. In fact, the probability, in random sampling, of obtaining a value of Y more unfavorable to the hypothesis than the observed value, say $\overline{Y}$, is

[4] Cf. R. von Mises, *Mathematisch Zeitschrift*, vol. 4 (1919) pp. 14–19.
[5] S. S. Wilks, *Biometrika*, vol. 24, (1932) p. 487.
[6] J. Neyman and E. S. Pearson, *loc. cit.* p. 295.

$$(2) \qquad P(Y<\overline{Y}) = B_{\overline{Y}}\left(\frac{N-n}{2}, \frac{n}{2}\right)$$

where the Incomplete Beta Function is,

$$(3) \qquad B_x(p, q) = \frac{\Gamma(p+q)}{\Gamma(p)\,\Gamma(q)} \int_o^x \theta^{p-1}(1-\theta)^{q-1} d\theta.$$

A significance test equivalent to $B_x(p,q)$ can be made by taking $z = \frac{1}{2} \log_e [(1-x)p/xq]$ and entering Fisher's z tables[7] with $n_1 = 2q$, and $n_2 = 2p$. It will be noted that Y and Hotelling's[8] T^2 are related by the equation $Y = (N-1)/(N-1+T^2)$.

The applicability of Y to the problem mentioned in the Introduction of comparing the averages of the attributes of the Panama skulls with those of the Mayans is fairly obvious. If this test should show non-significance, that is, P not very small, there is a possibility of non-agreement in the variances and covariances. However, this problem will not be considered here.

2. Hypotheses for two samples.

(a) *Hypothesis of a common set of means.* Let the means, variances and covariances in two samples of N_1 and N_2 individuals be $\overline{X}_{1i}$, a_{1ij} and $\overline{X}_{2i}$, a_{2ij} respectively ($i = 1, 2, \ldots n$). The hypothesis to be tested now is that the two samples come from populations having the same set of means ($m_{1i} = m_{2i} = m_{0i}$) when it is assumed that they have arisen from populations having the same system of variances and covariances ($\alpha_{1ij} = \alpha_{2ij} = \alpha_{0ij}$). In other words, if we have evidence for believing that the two sets a_{1ij} and a_{2ij} do not differ from each other significantly, we wish to proceed to test whether or not the two sets of sample means $\overline{X}_{1i}$ and $\overline{X}_{2i}$ differ significantly. The likelihood criterion for this hypothesis is[9]

$$(4) \qquad L_2 = \frac{|b_{ij}|}{|b_{ij}+c_{ij}|}$$

where

$$(5) \qquad Nb_{ij} = N_1 a_{1ij} + N_2 a_{2ij} \quad , \qquad N\overline{X}_i = N_1\overline{X}_{1i} + N_2\overline{X}_{2i}$$

$$Nc_{ij} = N_1(\overline{X}_{1i}-\overline{X}_i)(\overline{X}_{1j}-\overline{X}_j) + N_2(\overline{X}_{2i}-\overline{X}_i)(\overline{X}_{2j}-\overline{X}_j), \; N = N_1+N_2$$

Whatever values the b_{ij} may have (provided $|b_{ij}| \neq 0$) L_2 will be unity when and only when the c_{ij} vanish, which can occur only when the

[7] R. A. Fisher, *Statistical Methods for Research Workers*, 4th ed. (1932), pp. 224–225.
[8] H. Hotelling, "The generalization of Student's ratio," *Annals of Mathematical Statistics*, vol. 2 (1931), pp. 359–378.
[9] *Biometrika*, vol. 24 (1932) pp. 485–486.

respective means of the two samples are the same. As L_2 tends to zero the hypothesis that the means of the populations from which the two samples are drawn are the same becomes more and more untenable. The quantities $|b_{ij}|$ and $|b_{ij} + c_{ij}|$ are generalized variances with elements having $N_1 + N_2 - 2$ and $N_1 + N_2 - 1$ degrees of freedom respectively and L_2 is distributed according to a Type I curve. The significance test for an observed value of L_2, say $\overline{L}_2$, is given by

$$P(L_2 < \overline{L}_2) = B_{\overline{L}_2}\left(\frac{N_1 + N_2 - 1 - n}{2}, \frac{n}{2}\right). \tag{6}$$

(b) *Hypothesis of a common system of variances and covariances.* This hypothesis concerns whether or not the two sets of sample variances and covariances a_{1ij} and a_{2ij} could have arisen from populations having the same set of variances and covariances, whatever values the means may have. The likelihood criterion for this hypothesis is

$$L_1 = \frac{|a_{1ij}|^{N_1/N} \cdot |a_{2ij}|^{N_2/N}}{|b_{ij}|}. \tag{7}$$

L_1 satisfies our intuitive requirements in that it ranges from 0 to 1 and can be unity only when $a_{1ij} = a_{2ij}$ for all values of i and j. As L_1 tends to zero the hypothesis that the two samples come from populations having identical sets of variances and covariances becomes more and more untenable as far as we are able to judge from the samples. Under the assumption that this hypothesis is true, the sampling moments of L_1 are known, but it appears that in the general case the distribution function of L_1 must be approximated by fitting a Type I curve. However, if N_1 and N_2 are equal to N_0, say, then for large samples the quantity $N_0(1 - L_1^2)$ is approximately distributed like χ^2 with $\frac{1}{4}(n^2 + n)$ degrees of freedom. The significance test in this case is therefore quite simple. The condition that $N_1 = N_2 = N_0$ is not very strict because in many problems of practical importance it is easy to control the sample number.

(c) *Hypothesis of a common system of means, variances, and covariances.* The question to be answered here is whether the quantities a_{1ij} and $\overline{X}_{1i}$ differ significantly from the corresponding quantities a_{2ij} and $\overline{X}_{2i}$ all taken jointly. The criterion for testing this hypothesis is $L = L_1 L_2$. When $N_1 = N_2 = N_0$, the quantity $N_0(1 - L^2)$, in large samples, is approximately distributed like χ^2 with $\frac{1}{4}(n^2 + 2n)$ degrees of freedom.

The extension of the criteria L_1, L_2 and L and their respective sampling theory for the case of k samples of n variables has been given elsewhere.[10]

The application of these criteria to practical problems can be quickly illustrated in the quality control problem of testing for stability of hardness and tensile strength in several samples of aluminum die-castings. The different samples may, for example, be castings from different manufacturing units, or from different lots of raw material. In examining this set of samples several questions of practical importance may arise: (1) Are the variances and covariance of tensile strength and hardness stable from sample to sample? (2) If (1) can be answered in the affirmative, do the averages of strength and hardness in the several samples vary excessively? (3) Are the means, variances and covariance stable from sample to sample?

Logically, we should consider question (3) first, because if the sample value $\overline{L}$ of L is not significantly small there is no need to proceed to the other questions. We test the significance of $\overline{L}$ for k samples of two variables from the approximated probability function of L for small samples or by means of inequalities for $P(L < \overline{L})$ which are being investigated. If N_o, the number of items in each sample is large compared with k we set $\chi_0^2 = 2\,N_0(1 - \overline{L}^{k/2})$ and find $P(\chi^2 > \chi_0^2)$ from the χ^2 tables with $5(k-1)$ degrees of freedom. If $\overline{L}$ is significantly small we proceed to test the observed value $\overline{L}_1$ of L_1. The mechanics of the test are very similar to those for the test of $\overline{L}$. Unless $\overline{L}_1$ is not significantly small we should not proceed to test $\overline{L}_2$, the observed value of L_2, because the test for $\overline{L}_2$ is based on the assumption of stable variances and covariance. The significance of $\overline{L}_2$ is determined from the exact relationship [11]

$$P(L_2 < \overline{L}_2) = B_{\sqrt{\overline{L}_2}}\,(N-3,\ 1) \tag{8}$$

by means of the tables of the Incomplete Beta Function.

An important class of problems to which the L_2 criterion can be applied is that arising from replicated experiments. To illustrate, let us consider the case of two variables for "random blocks" lay-outs. For convenience, suppose the individuals of the sample are arranged in p rows, each containing q individuals. For example, we may consider grain and straw yield in a certain variety of cereal on each of

[10] *Biometrika*, vol. 24 (1932) pp. 488–490.
[11] *Cf. Biometrika*, vol. 25 (1933) p. 365.

pq plots arranged in p rows of q plots each. Let S_{ij} be the product sum of the deviations of observed values from their respective sample means of the i-th and j-th variates ($i, j = 1, 2$). If $i = j$ we get the sum of squares of the deviations of the i-th variate from the sample mean. Let S_{Rij} be the sum of products of deviations of means of rows in the i-th and j-th variates from the respective general means, the summation extending over all pq individuals of the sample. Let S_{Cij} be a similar function of deviations of means of columns, and let $S_{Eij} = S_{ij} - S_{Rij} - S_{Cij}$. Let us assume that for each of the two variates the population variance is the same in each of the pq plots and the population covariance between plots is zero, and furthermore, that the population mean of the i-th variate in the α-th row and β-th column is of the form $m_i + R_{\alpha_i} + C_{\beta_i}$. Then, whatever the values of the R_{α_i} may be, we can test the hypothesis that the C_{β_i} are zero; that is, that there is no significant effect on the values of the two variates "due to columns". The appropriate likelihood criterion for this hypothesis is

$$L_C = \frac{|S_{Eij}|}{|S_{Eij} + S_{Cij}|}. \tag{9}$$

The sampling theory of L_C is identical with that of the extension of L_2 to k samples of two variables, with N and k replaced by $p(q-1)+1$ and q respectively. It will be noticed that it is unnecessary to divide each element of the two determinants by pq, since both are of the same order. In the two variable case, the grain and straw problem for example, the significance test for an observed value of L_C is

$$P(L_C < \bar{L}_C) = B_{\sqrt{\bar{L}_c}}((p-1)(q-1)-1, q-1). \tag{10}$$

The test for effect "due to rows" is clearly obtained by replacing C and R and interchanging q and p in (9) and (10). This method can be applied to Latin square lay-outs, "equalized random blocks" and other replication designs, and can be extended to any number of variables.

3. Hypothesis of independence of groups of variates.

The hypothesis to be tested here is that a sample consisting of two groups of variates A and B having n_1 and n_2 ($n_1 \geqq n_2$) variates respectively, is from a normal population in which the variates in A are independent of those in B. By independence we mean that the correlation coefficient between each variate in A and every variate in B is zero.

The likelihood criterion for testing this hypothesis [12] is

$$\lambda_I = \frac{|a_{i_1 j_1}| \cdot |a_{i_2 j_2}|}{|a_{ij}|} \tag{11}$$

where $|a_{ij}|$ is the determinant of all sample variances and covariances (generalized sample variance) obtained by pooling the $n_1 + n_2 = n$ variates in A and B. $|a_{i_1 j_1}|$ and $|a_{i_2 j_2}|$ are the generalized sample variances for A and B respectively. λ_I will be unity only when the hypothesis of independence of A and B is rigorously supported by the sample, and it tends to zero when there is a linear function of the variates in A and a linear function of those in B which are perfectly correlated. In any case of this kind the hypothesis is contradicted by the sample. λ_I can easily be expressed in terms of correlation coefficients by dividing out the variances. To return to the example in the Introduction of testing for the independence between the two reading traits and two arithmetic traits we find λ_I as the ratio of a fourth order determinant to the product of two second order ones and the significance test is given by

$$P(\lambda_I < \bar{\lambda}_I) = B_{\sqrt{\lambda_I}}(N - 4,\ 2.) \tag{12}$$

When $n_2 = 1$, λ_I reduces to $1 - R^2$ where R is the multiple correlation coefficient between the single variate in B and the n_1 variates in A. When the number, N, of individuals is large the quantity $N(1 - \lambda_I)$ is approximately distributed like χ^2 with

$$\tfrac{1}{2}n(n+1) - \tfrac{1}{2}[n_1(n_1+1) + n_2(n_2+1)]$$

degrees of freedom. The theory of testing the mutual independence of several groups of variates has been given elsewhere.

4. Deviations from regression lines.

In economics and certain other fields of investigation in which statistical methods are applicable, it is important to consider deviations from trend lines and regression functions. When the trend lines or regression functions are linear combinations of functions of the independent variables and the coefficients entering into the regression functions are determined for each variable from the data by least squares, then all of the theory we have discussed (which concerns deviations from means) holds for the deviations from the empirically determined trend lines provided N is replaced by $N - r + 1$

[12] Cf. *Econometrica*, vol. 3 (1935) pp. 309–327.

where r is the number of coefficients in the regression function determined from the data.

SUMMARY

In the Introduction we have pointed out situations in various fields of investigation in which it would be useful to have comprehensive statistical tools for handling several variables simultaneously. When dealing with several variables certain general hypotheses arise as to the nature of the population from which the sample is drawn. These hypotheses cannot be adequately tested by considering the several relevant component statistics separately because of difficulty of being able to draw inferences regarding the hypotheses from collections of significant and non-significant values of the individual statistics. A given hypothesis must be tested by taking account of all of the relevant statistical functions simultaneously and examining their behavior in the light of probability. The problem of testing an hypothesis leads to the problem of designing a criterion for measuring the degree of departure of the observations from expectation, the expectation being based, of course, on the given hypothesis. The criterion is a function of observations and the problem of measuring the confidence to be placed in inferences from observations as to the truth or falsity of a given hypothesis leads to the problem of determining the probability function of the criterion associated with the hypothesis when the hypothesis is assumed true.

Without going into the technical details of their derivation we have discussed criteria of the Neyman-Pearson likelihood type for the following hypotheses which arise in the analysis of normal multivariate data:

(1) That a sample is from a normal population with specified means.
(2) That two or more samples are from populations having a common system of: (a) means; (b) variances and covariances; (c) means, variances and covariances.
(3) That several sets of variates are mutually independent.

Test criteria appropriate for certain extensions of the analysis of variance to several variables are considered, with special reference to "random blocks" lay-outs for replicated experiments.

The exact sampling theory of all of these criteria and their extension to regression problems, when the corresponding hypotheses are true, is known. In many special cases of practical importance it has been pointed out that the probability integrals are expressible in

terms of known functions which have been tabulated. In the case of large samples we have indicated that the significance of practically all of the criteria can be approximately determined from the χ^2 distribution, and have given the number of degrees of freedom in each case.

Finally, we must add that all of the criteria which we have considered are "Studentized" functions; that is, the criteria and their probability functions are completely expressible in terms of observations. This important property makes it possible to make mathematically rigorous inferences from sample to population independently of the values of the population parameters.

CONSTRUCTION COST INDEXES AS INFLUENCED BY TECHNOLOGICAL CHANGE AND OTHER FACTORS*

By Lowell J. Chawner

The calculation of cost indexes to be used in deflating production time series expressed in dollar valuation presents a number of problems which frequently have been ignored. This is especially true in construction where technological change and related factors are more important than is often realized. While technological change is discussed here primarily in relation to construction it reaches much farther in its implications. Theoretically it is involved in all synthetic or composite price indexes relating to products which are made under changing technological conditions.

"Construction cost indexes" of many types have been calculated and are currently available. They vary widely in their theoretical composition and representative character. For the purpose of commenting upon their theoretical basis of computation they have been classified into the four following groups:

1. *Composite price indexes of labor and materials only*, e.g., the Federal Reserve Bank of New York "Index of Cost of Building."
2. *Synthetic cost indexes*, based essentially upon labor-materials prices but also recognizing changes in other factors such as productivity of labor and contractors profits, e.g., the American Appraisal Company index of "Building Construction All Types."
3. *Unit-bid cost indexes*, based upon the unit bids of successful contractors, e.g., the United States Bureau of Public Roads "Price Trend in Highway Construction."
4. *Cost indexes of the completed product* as actually built, e.g., the Bureau of Public Roads "Index of Trends in Actual Cost of Highways per Mile." Indexes of this character are not often computed and find little use for the special purpose of deflation since the number of physical units is directly available nearly as frequently as are the dollar expenditures which they represent.

Each of these types of indexes has its legitimate uses. For the special purpose of deflating time series to disclose changes in the physical volume of a particular form of construction apart from changes in costs, and apart from changes in the facilities or other qualities provided, an index based upon the unit-bids of successful contractors should be used whenever possible. In certain cases where technological change has not been appreciable and where unit bids are not

* The writer wishes to acknowledge the opportunity for making studies in this field afforded by fellowships from Columbia University and Cornell University during the year 1934–1935 and to acknowledge the assistance of Miss Eleanor King and Miss Blanche Percy of the Central Statistical Board in preparing the charts.

readily available, an index built up from labor-materials prices together with all other elements of cost for which measures or numerical estimates are available may prove acceptable. A price index based upon labor and materials alone is unsatisfactory for the purpose of deflation as will appear in the following critical descriptions and subsequent theoretical analysis.

COMPOSITE LABOR-MATERIALS PRICE INDEXES

The indexes of this type now available are commonly criticized on the ground that the price quotations used in compiling the index are not those actually paid. This is true when the index is based upon union wage scales rather than actual rates, upon nominal materials prices rather than net payments after the deduction of varying and uncertain rebates and discounts, or upon wholesale rather than retail prices, i.e., in types of construction where purchasing is commonly done through local retail dealers.

An equally pertinent criticism is that of using weights for the different kinds of materials and classes of labor quite unsuited to the particular type of building or other construction which the contemplated index is assumed to represent. One of the most detailed and representative measures of the relative quantities of the materials used upon construction work is that provided by the Census of Construction of 1929.[1] In Table I value figures taken from the Census reports (*Construction Industry*, p. 29) and stated in terms of percentages of the total value of the several items shown are compared with similar figures derived by the Bureau of Labor Statistics. The latter are computed from quantity weights used in the wholesale commodity price index together with the 1926 price quotations for the several materials.

The wide differences revealed in this table together with the dissimilar movements in the prices of the several materials shown in Chart I [2] (particularly steel and lumber) suggest the desirability of

[1] See also the more recent studies of the U. S. Bureau of Labor Statistics: *Monthly Labor Review*, October 1932, "Relative Cost of Material and Labor in Building Construction," 1931–1932 (for fifteen cities); January 1935, "Relative Cost of Material and Labor in Construction of Water and Sewerage Systems"; and July 1935, "Relative Cost of Material and Labor of P.W.A. Building Construction." The last two articles give detailed proportions for all important materials as well as the proportions which labor and materials represent of the total cost.

[2] The relatives and the index plotted on Chart I are those of the U. S. Bureau of Labor Statistics wholesale commodity price index of building materials. The weights vary from time to time and are based substantially upon the quantity of a particular commodity sold as estimated from the *Biennial Census of Manufactures* and other sources. See Bureau of Labor Statistics *Bulletins*: No. 493, p. 4; No. 543, pp. 22–25; No. 572, pp. 7–9 and 104–106; and *Monthly Labor Review*, February 1935, for weights and for index figures used in plotting this chart. The weights used, although correct in computing a wholesale price index, result in a somewhat unsatisfactory distribution of emphasis in arriving at a measure of the prices of materials entering into any particular type of construction.

CHART I

INDEXES OF BUILDING MATERIALS PRICES
U. S. BUREAU OF LABOR STATISTICS

(Average, 1923–1925 = 100)

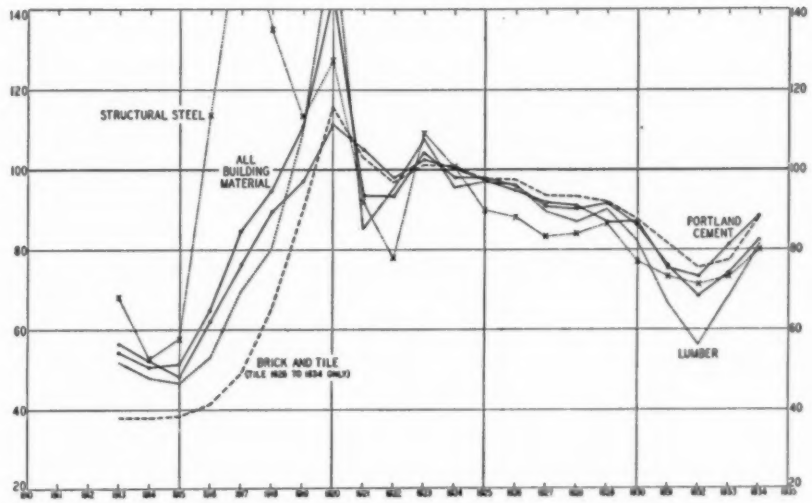


TABLE I

VALUES OF CERTAIN MATERIALS USED IN CONSTRUCTION IN PERCENTAGES OF THE TOTAL FOR THE ITEMS SHOWN

Commodity	Bureau of Labor Statistics*	Census of Construction of 1929		
		All classes of building†	Residential building†	All classes of construction
Lumber	36.2	23.7	44.7	10.2
Brick and tile	10.1	16.2	10.2	9.2
Cement	6.9	11.8	4.2	12.3
Structural steel	4.0	7.9	1.2	11.2
Paint, glass, etc.	10.3	1.7	2.4	2.9
Plumbing and heating	7.5	4.4	6.1	22.4
Sand, gravel and crushed stone	4.3	10.6	4.4	14.3
Millwork	3.5	11.6	19.8	4.1
Composition board	1.2	1.0	1.2	0.7
Hardware	3.3	3.7	4.8	1.7
Pipe (cast iron, etc.)	6.2	1.8	0.1	2.9
Pipe (vitrified, concrete, etc.)	2.0	0.2	0.2	1.8
Reinforcing steel	0.7	5.4	0.7	4.1
Asphalt, tar	3.8			2.2
Total	100.0	100.0	100.0	100.0

* Based upon the quantity sold in 1927-1929; introduced into the index January 1932. Price changes from 1926 to 1929 were downward but practically identical for all materials shown. The Bureau's weights for several other periods since 1920 were also computed and yielded results not essentially different from that shown here.

† The proportions for these two classes of building are somewhat deceiving in that the Census did not include here the material costs of sub-contractors. Consequently "plumbing and heating" is particularly out of line; 15 to 25 per cent would be more nearly of the proper order of magnitude for this item.

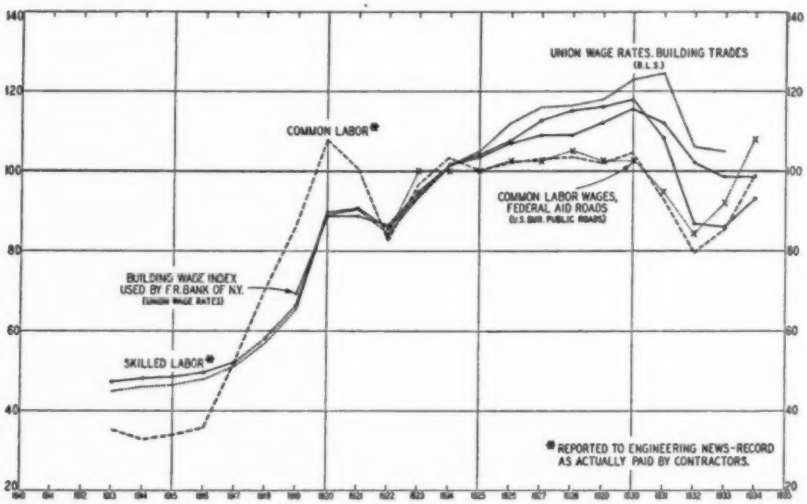
special purpose index numbers for determining the trends in material prices for each major class or type of construction.[3] The wage rates for skilled and unskilled labor also exhibit dissimilar movements from year to year as disclosed in Chart II.[4]

Notwithstanding these difficulties a number of indexes based upon the prices of labor and materials without allowances for other factors

CHART II

INDEXES OF CONSTRUCTION WAGE RATES

(Average, 1923–1925 = 100)


UNION WAGE RATES, BUILDING TRADES (B.L.S.)
COMMON LABOR*
COMMON LABOR WAGES, FEDERAL AID ROADS (U.S. BUR. PUBLIC ROADS)
BUILDING WAGE INDEX USED BY F.R. BANK OF N.Y. (UNION WAGE RATES)
SKILLED LABOR*
* REPORTED TO ENGINEERING NEWS-RECORD AS ACTUALLY PAID BY CONTRACTORS.

[3] Special purpose indexes of this character were developed and made available for several years for frame and brick houses by the Division of Building and Housing of the Bureau of Standards. These indexes unfortunately have not been available since the discontinuation of the statistical work of that Division in June 1933.

[4] The wage rates shown on Chart II may be briefly described as follows:

(a) U. S. Bureau of Labor Statistics, Union Wage Rates, Building Trades, principal cities of the United States. Based upon May 15 quotations. See *Bulletin* No. 347, p. 7; *Monthly Labor Review*, March and April 1933; and *Bulletin* 660 for the quotations upon which this index is based.

(b) Building Wage Index used by the Federal Reserve Bank of N. Y. This index is based upon union wage rates from several sources:
1919–1921, *Monthly Labor Review*
1922–1930, *American Contractor*
1931 to date, Wage Index of the F. W. Dodge Corporation

(c) Construction Wage Rates, *Engineering News-Record*. Since 1922 the data upon which this index is based have been obtained from contractors in 20 cities; before that date the quotations represent a fewer but unstated number of cities. See "Construction Costs," *Engineering News-Record*, 1935 edition, p. 11. The wage quotations are intended to represent wages actually paid and are reported as such by contractors. Monthly as well as annual quotations are available for skilled and for common labor from January 1922 to date.

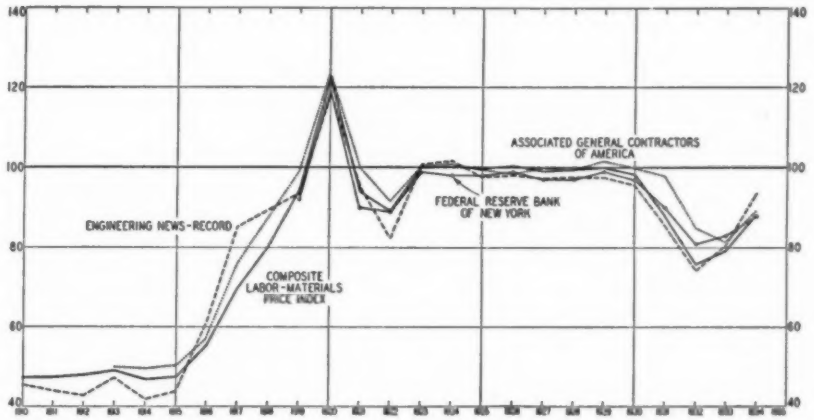
(d) Bureau of Public Roads, common labor wages, compiled directly from Federal aid project reports, average of the United States. Data from *Statistical Abstract of the United States*.

relating to cost have been computed and are widely used. Three of these indexes are shown on Chart III.[5] A fourth index of this type has been prepared by the author to be used as a common basis of

CHART III

LABOR-MATERIALS PRICE INDEXES, BUILDING AND OTHER CONSTRUCTION

(Average, 1923–1925 = 100)



[5] The labor-materials price indexes shown on Chart III may be described as follows:

(a) Federal Reserve Bank of New York, "Index of Cost of Building," weighted composite of Bureau of Labor Statistics building materials prices, 55; and union wage rates, 45; revision of 1932.

(b) Associated General Contractors of America, weighted composite index of prices, materials, 60, and labor, 40. Reported in the *Survey of Current Business* and there described (1932 annual supplement, p. 288):
"The wage figures are those reported for hod carriers and common labor by the National Board of Builders Exchange for 12 cities. . . . The materials prices are averages for the same 12 cities as compiled by the *Engineering News-Record* for the following materials: sand, gravel, crushed stone, Portland cement, common brick, lumber (all weighted equally), hollow tile (weighted one-half), and structural steel and reinforcing steel (both together weighted one-half)."

(c) *Engineering News-Record*, "Construction Cost Index." Reported as of the first of each month in the *Engineering News-Record*. Described in detail in the July 21, 1921 number of that publication. It is an aggregative index, the quantities being 2,500 lb. of structural steel (priced, Pittsburgh base), 6 barrels of Portland cement (priced, f.o.b. Chicago), 600 feet board measure of southern pine lumber (priced at New York), 200 man-hours of common labor (the average price from 20 cities being used here since 1919). This index in its weighting is more nearly applicable to heavy engineering construction than any of the other *price* indexes presented here. It is, however, somewhat overweighted in steel and common labor and underweighted in Portland cement and skilled labor (not included in the index). This weighting together with the use of the wages of blast furnace labor prior to 1919 (the closest monthly wage series then available) accounts for the sharp rise of the index in 1917 and 1918 and the decline in 1922. Beginning in 1922 and continuing to date the wage rates used have been those reported as actually paid in 20 cities. These rates appear to be more representative of wages in private construction than any others available for this period. This index has a special advantage of being promptly available after the first of each month.

comparison throughout these charts.[6] The annual values for this index are shown in Table II.

TABLE II

LABOR—MATERIALS COMPOSITE PRICE INDEX

Year	Index number	Year	Index number	Year	Index number
1910	47.1	1920	122.3	1930	98.4
1911	47.3	1921	93.9	1931	88.1
1912	47.9	1922	89.1	1932	75.5
1913	48.9	1923	100.0	1933	79.3
1914	46.7	1924	100.2	1934	88.2
1915	47.3	1925	99.8		
1916	55.2	1926	100.3		
1917	69.6	1927	99.1		
1918	80.1	1928	99.5		
1919	94.2	1929	100.1		

This index has been computed using the most satisfactory weights and price quotations available for building of all types covering the period indicated. It should be considered, however, not as a measure of costs but as an approximate measure of the trends in labor-materials prices in building construction and, moreover, is not strictly

[6] *Composite Price Index.* The wage rates, skilled and common are those of the *Engineering News-Record*, reported by contractors as actually paid. The material prices are those of the Bureau of Labor Statistics.

Investigations of the American Appraisal Company (made available through the courtesy of Mr. Lyle H. Olson, Vice-President of that company) indicate that skilled labor in building construction represents approximately 90 per cent and unskilled labor approximately 10 per cent of the labor outlay. In other construction skilled labor is a smaller proportion of the total but the author has no accurate measure of this factor. Weights of 67 per cent skilled and 33 per cent common labor were used in this index. They very likely underestimate skilled labor, but in doing so emphasize the rates which are the least likely to be affected by nominal wage scales.

The following table presents several measures of the value proportions by which materials and labor enter into construction costs. The proportions in each case are in terms of the prices for the year in which the studies were originally made as well as in terms of 1923–1925 prices. Based largely upon the data shown here, materials and labor have been combined in the proportions of 60 and 40 respectively.

MATERIALS—LABOR PROPORTIONS

Sources of weights	Year	Value proportions for year indicated		Value proportions adjusted to 1923-25 average prices	
		Materials	Labor	Materials	Labor
American Appraisal Co.—average of 5 types of building	1913	63.8	36.2	58.0	42.0
Bureau of Labor Statistics, 3 cities—*Monthly Labor Review*, October 1932	1928	58.2	41.8	63.0	37.0
Census of Construction of U. S.—all types of construction	1929	58.3	41.7	62.7	37.3
Bureau of Labor Statistics, all types of buildings — *Monthly Labor Review*, October 1932	1932	63.6	36.4	68.0	32.0

Chance variation might account for the change which appears to have taken place in the proportions from 1913 to 1932. However, the above data do accord with common knowledge in the *building* industry to the effect that the relative outlay for labor over the period indicated has remained approximately the same, wage increases being offset by decreases in the number of man-hours of labor required.

applicable to any particular type of building. Similar observations may be made regarding labor-materials price indexes in general. When properly weighted and based upon representative quotations they may be quite useful to contractors and others in estimating trends in the prices of these two items entering into construction, particularly when computed for labor and materials separately. As measures of true cost, however, they should not be used for the reasons stated in the following section.

SYNTHETIC INDEXES AND TECHNOLOGICAL CHANGE[7]

It might appear that changes in technology could be accounted for by a proper and accurate shifting of weights from time to time. Such, however, is not the case. Technological change involves not only a shift in the *proportions* of the several elements entering into the production of a commodity but also an actual increase or decrease in the physical *quantities* of these elements (especially labor), the finished product remaining identical throughout. Such a change has been taking place in nearly all branches of construction in the United States for some time and has been conspicuous in heavy engineering work. In highway earthwork, for example, large bucket graders of five to eight cubic yards capacity operated by one or two men have widely replaced the mule-team Fresno scraper crews of a decade or two ago. Similar changes have taken place in the mixing and placing of mass concrete and in many other construction activities. This change, however, has been statistically measurable only within the past two or three years through the development of the several types of indexes mentioned earlier in this paper.

The statistical distinction between indexes of prices and of unit costs may be put into numerical form as has been done in the following example. Two elements A and B enter into the production of a commodity. The prices and quantities of the two elements required in each of two years, a base year and given year, are known. From these data, simple price indexes and a unit-cost index are determined.[8] The cost in the given year is clearly equal to the cost in the base year

[7] Technological change also bears upon several price aspects of economic and statistical theory other than that elaborated in this paper. For example, during periods of substantial technical progress in manufacturing, indexes of basic commodity prices, as has often been observed, furnish quite an unsatisfactory measure of general price movements. Indeed the "general price level" under such conditions becomes exceedingly difficult to measure.

[8] Although hypothetical, this example (A being material and B, labor) is illustrative of the actual tendencies in highway construction and is substantially applicable to the two years 1916 and 1932. In building construction the discrepancy is much less than in highways and other public works but is nevertheless appreciable, of the order of 10 per cent, over this period.

Element	Base Year			Given Year		
	Price	Quantity	Cost	Price	Quantity	Cost
A	100	1.00	100.0	100	1.00	100.0
B	100	1.00	100.0	190	.526	100.0
Total			200.0			200.0

and the unit-cost index is thus 100. The price indexes, however, would be as follows:

(a) Using base year quantities as weights,

$$\frac{1 \times 100 + 1 \times 190}{1 \times 100 + 1 \times 100} \times 100 = 145.0$$

(b) Using given year quantities as weights,

$$\frac{1 \times 100 + .526 \times 190}{1 \times 100 + .526 \times 100} \times 100 = 131.1$$

(c) And taking the geometric mean to arrive at the "ideal index,"

$$\sqrt{145.0 \times 131.1} = 138.0$$

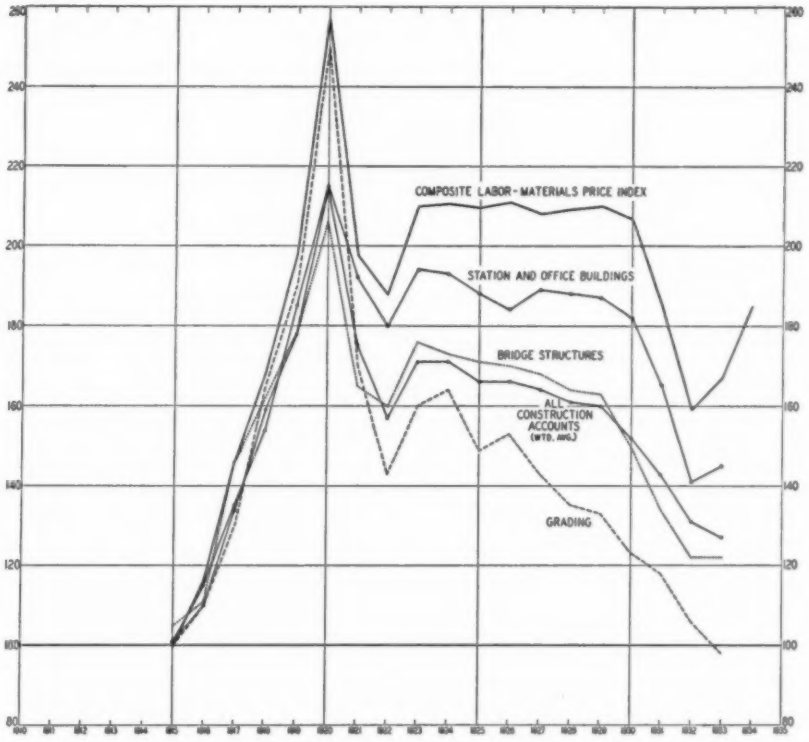
The value 138 is thus the best representative measure of the *prices* of the commodities in the given year if that measure in the base year be taken equal to 100. It is, however, an unsatisfactory measure of the relative *cost* of the product in the given year as compared with the cost in the base year. Such a measure would be 100 as already observed. It should be noted that this example does not include all of the collateral changes that might accompany a decrease in the quantity of labor. It merely illustrates in simple numerical terms the essential distinction between a "price index" and a "unit-cost index." However, when price indexes of the usual type are compared with actual cost records over long periods of time the discrepancy mentioned above clearly becomes very large, substantially of the order of magnitude suggested in this numerical illustration, (See Chart IV.)

In types of construction where technological change and fluctuations in labor productivity (or in profits) are appreciable, conventional price indexes are unsatisfactory. For use in connection with such series some sort of actual cost index must be used. It is theoretically possible to develop a formula which will yield such an index using current price quotations together with average changes in the relative quantities entering into any process of manufacture or construction. Although not of practical value here at the present time these equations when compared with price index formulas clearly reveal the essential differences between these two types of indexes.

CHART IV

INDEXES OF RAILROAD CONSTRUCTION COSTS, BUILDINGS AND HEAVY CONSTRUCTION,* U. S. INTERSTATE COMMERCE COMMISSION, BUREAU OF VALUATION

(Average, 1910–1914 = 100)



* Not all accounts are represented here (there are 40 construction accounts alone). However, this chart shows several of the largest accounts as well as the weighted average of all construction accounts. The data for the year 1934 are not yet available.

A price index in its most widely used form involves the pricing of a *fixed group of commodities* at two periods, a base period and the period for which the index is desired. The fixed quantities are frequently those of the base period or those of the given period and result in equations of the well known type which are frequently averaged by taking their geometric mean to give the "ideal" index,

$$I = \sqrt{\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}} \qquad (1)$$

A cost index involves the determination of the cost of a *standard*

product, also at two different periods, but is influenced not only by the prices but also by the quantities of the elements entering into its production. The standard product may be a general conception or, in the case of construction, a composite of several specific structures, buildings, dams, bridges, etc., each of fixed design and specifications and combined in proportion to properly represent the series to be deflated. Such a cost index is the sum of the costs of the standard product in the given year divided by the sum of the costs of the identical product in the base year.

It may be expressed algebraically as follows:[9]

$$I_C = \frac{p_1'q_1' + p_1''q_1'' + \cdots}{p_0'q_0' + p_0''q_0'' + \cdots} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_0} \qquad (2)$$

in which p', p'', . . . and q', p'', . . . are the prices and the quantities respectively of the several elements, labor, materials equipment, insurance, supervision, current construction loans, performance bonds, and other items entering into the cost of the standard product. The essential distinction between equation (1) and equation (2) rests in the quantity term. In a price index, (1), the quantities, in the very essence of the case, remain constant. However, in a cost index, (2), when technological changes are present, both prices and quantities are variable.

The data required for substitution in these equations are becoming increasingly available but as suggested above are still inadequate for practical purposes. The development of satisfactory indexes of construction costs must consequently be sought whenever possible in the unit bids of successful contractors. In cases where unit-bid data are not available it may be necessary to develop synthetic indexes of costs which are based essentially upon labor-materials prices but which also make careful allowances for other major items influencing costs. On Chart V are shown two indexes of the latter type and one of the former.[10]

[9] When the prices and quantities are available as relatives only, equation (2) may be expressed as follows,

$$I_C = \Sigma\,(p_1/p_0)\,(q_1/q_0)\,w_0$$

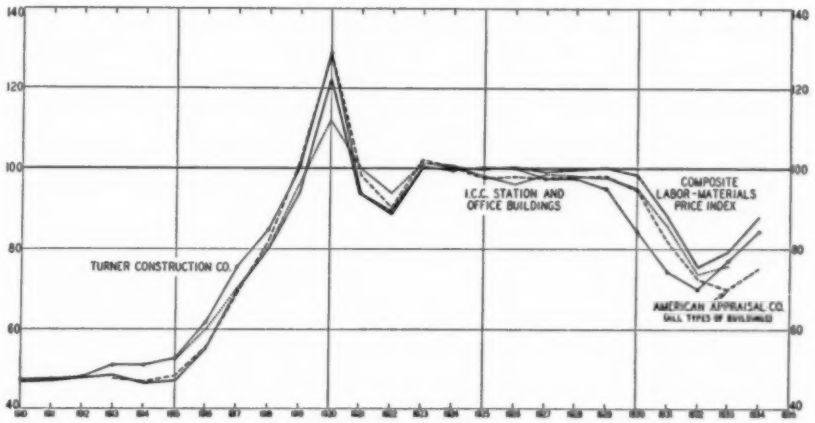
in which (p_1/p_0) is clearly the price relative for a given year, (q_1/q_0) is a quantity relative for a given year, the ratio of the quantity of any element required in the given year to the quantity required in the base year, and w_0 is the proportion which the cost (quantity times price) of a given element in the base year is of the total cost in the base year.

[10] (a) American Appraisal Company, Building Construction All Types. This index is based upon four types of buildings, all-wood-frame, brick-wood-frame, brick-steel-frame, and reinforced concrete. The quantities used in computing the index are determined from cost studies of actual construction work and thus estimate "labor efficiency" and technological change. The index was formerly computed for each type of construction in nine different parts of the United States. For the four types (also steel mill buildings) it has been available since 1913 and for a lesser

CHART V

INDEXES OF BUILDING CONSTRUCTION COSTS

(Average, 1923–1925 = 100)



A number of other indexes designated as building or other cost indexes, prepared in most cases by contracting organizations, have been investigated. In several instances they were found to be more properly labor-materials price indexes. In other cases, although

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number of types of construction as far back as 1852. For the earlier years annual averages only were computed, then from 1915 to 1923 the averages were quarterly, and beginning in 1924 have been determined each month. Since 1932, however, the index has been available only as a general average for all types together with a range of values which depend upon the particular type of construction, the location, and the exact date. It is published in the *Clients Service Bulletin* of the company and is also reported each month in the *Survey of Current Business*.

(b) Turner Construction Company, Building Cost Index. This index is based not only upon current prices of materials and labor but, "goes much further than this by including factors of the productivity of labor, improvements in construction plant and construction management, and competitive conditions all as determined by actual cost records." (See statement by H. H. Fox, Vice-President, Turner Construction Company, in Construction Costs, *Engineering News-Record*, 1935 edition, p. 21.) Although this company engages in business over a considerable area, its experience is not altogether representative of the country as a whole. Moreover, its methods of operation are quite modern which might tend to keep its costs somewhat lower than the average, i.e. in so far as competitive conditions did not bring the bids of other contractors to the level of the more efficient operator.

(c) Interstate Commerce Commission, Bureau of Valuation, Engineering Section, Station and Office Buildings. The classification of the Commission includes nine accounts which refer to buildings; the largest account (50 per cent of all buildings) is shown here; the trends of the others closely resemble the one which is plotted. In so far as possible, the valuations of the Bureau are based upon the analysis of major construction contracts over the period covered and have been supplemented by the studies of the several district sub-committees of valuation engineers of the Presidents' Conference Committee. In all cases the index figures are intended to represent the actual costs of construction. The indexes are available from 1915 to 1933 for each of the eight regions of the country as well as for the average for the United States which is shown here. The data were made available by the Bureau of Valuation of the Commission in a mimeographed pamphlet dated January 19, 1934.

attempting to properly measure true cost, they were found to be quite local in representative character.

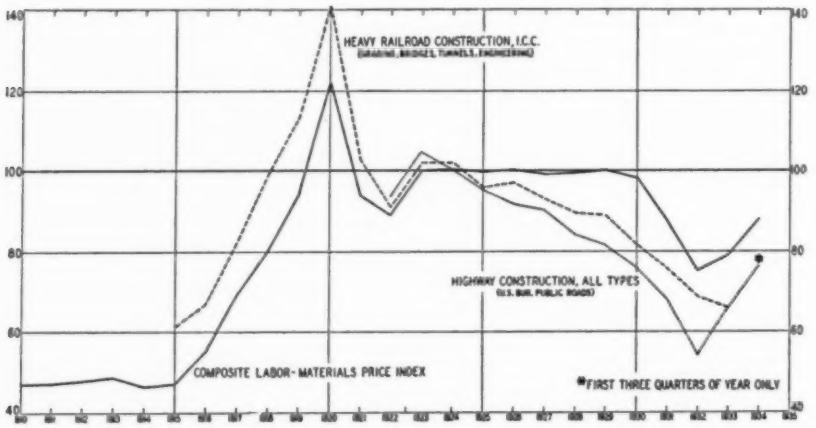
UNIT-BID COST INDEXES

In the case of heavy engineering construction and, as has just been observed, for some buildings, indexes are available based upon the unit-bid quotations of successful contractors for a large number of works and structures. The carefully computed indexes of the Interstate Commerce Commission and the U. S. Bureau of Public Roads (see Charts IV and VI) are of this type.[11] Such indexes are based

CHART VI

INDEXES OF HEAVY ENGINEERING CONSTRUCTION COSTS

(Average, 1923–1925 = 100)



[11] (a) Highway Construction Costs. U. S. Bureau of Public Roads. Reported in detail in *Public Roads*, Vol. 14, pp. 81–92, by Mr. J. L. Harrison, Senior Highway Engineer. Recent data for 1933 and 1934 were made available through the courtesy of Mr. T. H. MacDonald, Chief of the Bureau. This index is based upon the actual bids of successful contractors upon highway work in the United States. Prior to October 1931, the bids used were from Federal aid construction only; since that date, bids upon other state work have also been included. The construction items entering into the index are: excavation (common plus other items expressed as equivalent common excavation), pavement (Portland cement concrete plus equivalent other items expressed as Portland cement concrete), reinforcing steel, structural steel, structural concrete. The weights used by the Bureau were taken as proportional to the quantities actually entering into Federal aid roads during the fiscal years, 1925 to 1929. The index is available by years beginning with 1922 and by quarters beginning with 1931.

(b) Railroad Construction Costs. Interstate Commerce Commission, Bureau of Valuation. The indexes shown on Chart IV disclose the trends in the costs of the major construction items, both of buildings and heavy engineering construction. The index shown on Chart VI is based upon four typical heavy engineering construction accounts, grading, bridges, tunnels, and technical engineering, which have been combined in proportion to the value by which each enters into the total valuation of the roads as determined by the Commission. The values for 1934 are not yet available.

upon the unit-bids of successful contractors upon actual construction work, construction which presumably is included in the very totals which it is desired to deflate. Typical items for which quotations are commonly available are cubic yards of earth or rock excavation; tons of structural steel erected in place; cubic yards of foundation, mass, or structural concrete in place; thousands of brick in place; etc. The quotations upon these items, it should be observed, include the contractors estimate of all elements of cost, labor, materials, interest, insurance, equipment, profit, etc. and are actual measures of both the quantities and the prices of all elements of cost.

Certain difficulties in this method have, nevertheless, been observed and should be considered here. The data although numerous are far from complete, they include some unbalanced bidding, can seldom be perfectly classified, and often are difficult to identify in relation to particular series of contract awards. The first objection is more imaginary than real. In the case of the two cost indexes mentioned above the data are in fact voluminous and widely representative as will appear from their description. Unbalanced bidding is frequently practiced but much less flagrantly since, than before, about 1920. The practice consists in entering one bid quotation higher and another correspondingly lower than true cost. This may be done (although presumably not permitted) for several reasons: (1) to conceal actual costs from competitors, (2) when payments are made upon completion of stated parts of the work, to secure a large early payment as a means of financing the operation, (3) to take advantage of inaccurate representation of the actual quantities involved (sometimes through collusion with governmental or other officials). The difficulties introduced by this practice are genuine but may be largely offset by using care in incorporating into any unit-bid index items which enter into each major stage of the construction process and by rejecting quotations from projects in which this is not possible. The general problem of classification is no greater than that experienced in dealing with many other economic data. Careful work here is likely to result in distributions, the central tendency of which is quite as clearly measurable in nation wide samples as those for common labor wage rates, electric light and power rates, coal prices, and similar items which might be mentioned. Care and statistical skill must be used in handling these data but the task presents no insurmountable theoretical difficulty. In so far as the writer has been able to determine, the indexes of this type compiled by the Interstate Commerce Commission and by the Bureau of Public Roads appear to be unusually

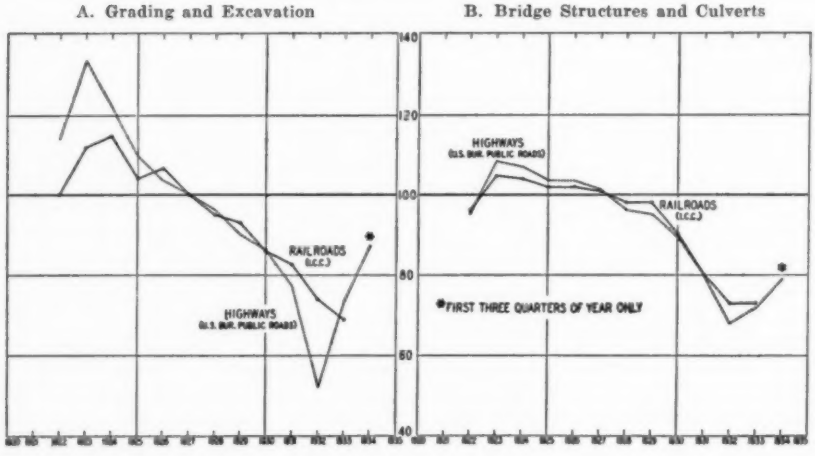
free from criticism either upon theoretical grounds or in their actual compilation.

Charts VIIA and VIIB were plotted as a graphical aid in studying the similarity or the differences which might exist in the fluctuations from time to time in very special types of construction cost indexes (e.g., Grading and Excavation, or Bridge Structures and Culverts) determined largely by the unit-bid method, each by two entirely different statistical organizations, and obtained from widely scattered parts of the country. The work represented by either of these indexes is much the same whether it be for highways or railroads. Consequently, unless the statistical method used yields unsatisfactory results, we should expect a fair agreement between the curves in each case, subject to known factors peculiar to any one series. In Chart VIIA the indexes are clearly in accord with expectation in a remarkable degree. Although grading and excavation costs declined from

CHART VII

COMPARISON OF INDEXES OF CONSTRUCTION COSTS, TWO TYPES OF HEAVY CONSTRUCTION

(Average, 1925–1929 = 100)



1923 to 1932 in railroad as well as highway construction, the technical progress was notably greater in the latter than in the former. Beginning in 1933, however, higher wages were enforced by governmental bodies upon highway contractors and efforts were made to distribute a large part of public works expenditure directly upon labor. These measures would tend to account for the increases in bid-costs which appear in 1933 and 1934. In Bridge Structures and

Culverts (Chart VIIB) in which materials represent a substantial part of the cost, the agreement between the two indexes is remarkable. The slight differences which do appear, accord with known technical and regulatory factors in each case.

Indexes of construction cost based upon unit-bid quotations have many advantages for the purpose of deflating time series expressed in dollar valuation. The principal one is that they rest upon samples from the very figures which multiplied by the number of units of a particular item gave the dollar valuation which forms a part of the total which it is desired to deflate. They also include factors otherwise difficult to determine such as changes in profits, technological methods, labor productivity, etc., and when properly computed give the most satisfactory measure available for our present purpose. Indexes of this character might be much further extended if the large quantity of data available for many years past in various engineering publications and in the files of many governmental bodies were put to this use.

Historical cost indexes of this character, however, have the disadvantage of being available only in annual or quarterly series and, in the opinion of the writer, no attempt to compute such indexes in other (monthly) terms would give satisfactory results. A simple method has, nevertheless, been developed for translating historical cost indexes into monthly values by using such indexes for year to year variations and monthly price indexes for interim fluctuations. The method accords with the facts and is relatively simple to use.

CONCLUSION

This discussion has been concerned throughout with construction cost indexes as they may be used for the deflation of value series of building permits and contract awards of wide coverage. No claim is made for the use of indexes in the valuation or appraisal of particular structures. Local physical peculiarities and special economic characteristics are frequently so great as to preclude their use in estimating present worth or value. (For a somewhat different view see, "Approximation of Appraisal Values by Index Numbers." Henry W. Sweeney, *Harvard Business Review*, Volume XIII, Number 1, October 1934). In terms of statistical measures of central tendency relating to a group of many works and structures of a given type the use of properly computed index numbers of construction costs is clearly valid.

Not all types of construction cost indexes, however, are equally suitable. Those now available based upon labor-materials prices are

largely unsatisfactory since the quotations commonly used are not those actually paid, the weights are seldom specifically related to the type of construction under consideration and the theoretical basis of computation is in error in that it does not recognize such important factors as changes in technology, labor productivity per man-hour, and profits. Objections relating to quotations and weights can be largely removed by improved reporting and careful determination of proper weights. Some progress is being made to that end at the present time, largely by government agencies. To obviate the objections relating to technological change and productivity of labor certain synthetic indexes which attempt to combine estimates of these and similar factors with labor-materials prices have been prepared. Indexes of this type are clearly preferable to those based upon labor-materials prices alone but are not considered to be as satisfactory measures of actual cost as are indexes based upon the unit bids of successful contractors. Over long periods of time where technological change has been appreciable unit-bid indexes are clearly preferable to cost indexes of any other type. When indexes of this description are carefully computed and when they are designed to represent the series to which they are intended to refer it is believed that they are quite satisfactory for their designated purpose.

NOTES

SIZE OF COMPLETED FAMILIES

By E. B. Wilson and M. M. Hilferty, *Harvard School of Public Health*

The interesting observation of B. S. Burks[1] that a table of the number of children born according to birth order enables one to estimate, for a stationary population, the size of completed families deserves further attention.[2] Gini, in a paper which presumably went to press at about the same time as that of Burks, points out, if we understand him aright, that the population need not be stationary provided the numbers of births and of first births are constant.[3]

It happens that tables of births by order for New York State other than New York City[4] are available from 1920 to 1933 inclusive and show a remarkable constancy (except for fluctuations that might be natural to the business cycle which had large swings in that period) not only in the total number of births to native white mothers but in the distribution of that number over the different birth orders.[5] The total number of births by orders from one to nineteen for the fourteen years is shown in Figure I on ratio paper. It is clear that by and large the number of births of orders 1 to 11 line up[6] with a constant decrease at a ratio which is about .67 whereas those from 12 to 19 also line up, but with a ratio that is less and about .53. (*See* Table I)

The Burks formula or rule for finding the expected average numbers of births in a completed family which has at least one birth is

[1] B. S. Burks, this Journal, Vol. XXVII, Dec. 1933, pp. 388–394. Gini, *ibid*, Vol. XXIX, June 1934, p. 200, points out that he had priority with respect to this observation. It is unfortunately a fact that the indexing of demographic articles, which are very widely scattered in the literature, is not reduced to such a system as makes it possible for a student to know, except by accident, what has been done.

[2] Burks's (and Gini's) observation is not restricted to a table of births according to birth order, but deals with any random sample of the population; moreover Burks gives formulas for standard errors of the estimates as derived by J. R. Oppenheimer.

[3] Gini, *XXI^e Session de l'Institut International de Statistique*, Mexico, 1933. "Sur la mesure de la fécondité des mariages.", La Haye, 1933. See especially the last paragraph of p. 23 and the second paragraph of p. 22.

[4] *Annual Reports of the State Department of Health*, Albany, N. Y.

[5] The constancy is not apparent for births to foreign born white women nor to colored women. Moreover the age distribution of foreign born white mothers was changing rapidly from 1925 to 1933.

[6] There are systematic departures; for example, the point for birth order 2 lies above the line and the departure is not accidental because it is a phenomenon which appears repeatedly in the figures for the individual years. What we have described as a break in the slope at around birth orders 11 to 12 is undoubtedly a gradual transition, but there seems to be no simple smooth curve that will give a particularly good fit.

FIGURE I

TOTAL BIRTHS TO NATIVE WHITE MOTHERS, BY ORDER OF BIRTH, 1920–1933, NEW YORK STATE EXCLUSIVE OF NEW YORK CITY

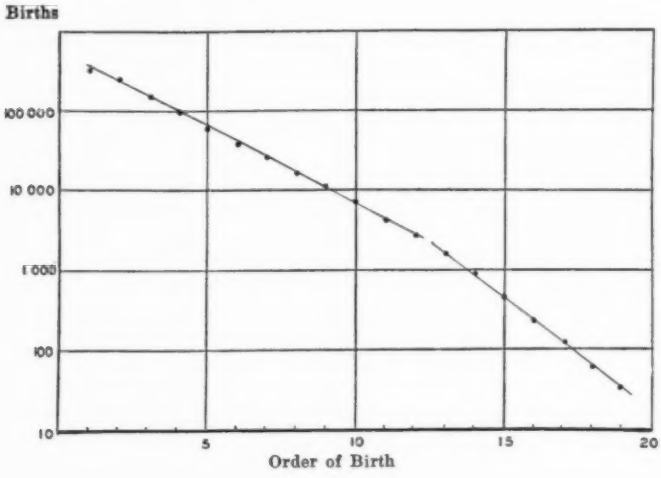


TABLE I

TOTAL BIRTHS TO NATIVE WHITE MOTHERS, BY ORDER, 1920–1933, AND RATIO OF BIRTHS OF ORDER $i+1$ TO BIRTHS OF ORDER i, NEW YORK STATE EXCLUSIVE OF NEW YORK CITY

i	Births	B_{i+1}/B_i	i	Births	B_{i+1}/B_i	i	Births	B_{i+1}/B_i
1	339,771	.733	8	17,112	.652	15	468	.498
2	248,920	.623	9	11,157	.655	16	233	.515
3	155,114	.613	10	7,312	.602	17	120	.51
4	95,054	.625	11	4,405	.612	18	61	.56
5	59,445	.650	12	2,697	.600	19	34	
6	38,641	.663	13	1,618	.572	20+	39	
7	25,610	.668	14	926	.505			

to take the quotient of all births by first births.[7] Insofar as the method is applicable, it would seem to admit of an immediate extension to estimate, at any birth i, the number of future births to be expected, by simply dividing the number of births of order higher than i by the number of births of order i. Based on the total fourteen years we have the results in Table II.

The striking thing about Table II is the remarkable constancy of the expected future number of births after that of order i from $i=1$ to $i=8$; the fluctuations about the mean 1.80 (of these eight)

[7] This gives the expected completed number of children in fertile families. Gini uses also marriages and by dividing total births by marriages, each per annum, finds the average size of family whether fertile or sterile, but for New York State other than New York City there seem to be troublesome corrections to estimate because of non-resident marriages.

TABLE II

EXPECTED NUMBER OF FUTURE BIRTHS IN A FAMILY WHICH HAS HAD A GIVEN NUMBER i WITH STANDARD ERRORS* FOR THOSE NUMBERS BASED ON THE ANNUAL NUMBER OF BIRTHS

i	Expected	i	Expected	i	Expected
1	1.97 ± .016	7	1.80 ± .052	13	1.17 ± .15
2	1.69 ± .016	8	1.70 ± .061	14	1.03 ± .18
3	1.71 ± .020	9	1.60 ± .072	15	1.04 ± .25
4	1.79 ± .027	10	1.45 ± .082	16	1.09 ± .37
5	1.86 ± .035	11	1.40 ± .103	17	1.12 ± .53
6	1.86 ± .044	12	1.29 ± .124	18	1.20 ± .78

* The standard errors are by the Oppenheimer formula; actually the dispersion of the values by years is considerably larger for the first two.

are, however, systematic as may be seen by comparing similar tables for the different years. It may be observed that even for the highest orders the expectation is for more than one additional birth—though not significantly so. If the time-trends of the expectations for the various values of i for the period 1920–1933 be examined several of them appear statistically significant, and a similar result may be had by figuring the table for groups of years such as 1920–1923, 1925–1928, 1930–1933 or 1920–1926 and 1927–1933. The tendency revealed is for the expectations for $i = 1$ and 2 to decline, for $i = 3$ and 4 to remain stationary, and for those for $i = 5$ and over to increase. Whether this really means that the small fertile families are getting smaller and the large larger may be doubted,—the period covered is short, the business cycle was exceptional, the population was not stationary and we have found no adequate way of allowing for the effects of a variety of possible disturbances. The percentage distribution of the expected size of completed fertile families indicates that the one and two birth families are of about equal frequency, each being about 27 per cent of the total.

It is interesting to compare these results with some data from genealogies relative to the size of completed families as recorded therein.[8] (See Table III.) Whether the decreases shown with time are reliable we cannot say, but at least it appears as though the mean family prior to 1800 was about 6 and that for the Waldos there had been a drop to about 3.7 by the second quarter of the 19th century as against a present figure for native mothers of about 3.0. Finally

[8] The data are taken from the punched cards of Dr. C. R. Doering prepared from the genealogies of the Hydes, the Waldos and the Stones. It may be pointed out by way of caution against putting too much faith in the data for purposes of comparison that we are forced to use the mothers of recorded size of family rejecting the numerous cases where the size of family is unknown. (If a woman was married more than once the number of births credited to her is only that of the most productive of the marriages.)

TABLE III

MEANS AND MEDIANS OF SIZE OF COMPLETED FERTILE FAMILIES BY PERIOD OF BIRTH OF MOTHERS

Period	Hydes		Waldos		Stones	
	Mean	Median	Mean	Median	Mean	Median
Before 1750	6.1	5.2	—	—	—	—
1750-1774	5.9	5.8	—	—	—	—
1775-1799	5.1	4.7	—	—	—	—
Before 1800	—	—	6.0	6.1	6.5	6.5
1800-1824	—	—	4.5	3.8	—	—
1825-1849	—	—	3.7	3.1	—	—

Table IV gives a comparison of the percentage of completed families of the different sizes for the three genealogies prior to 1800 and for the present estimates for New York State other than New York City.

TABLE IV

PERCENTAGE OF COMPLETED FERTILE FAMILIES HAVING GIVEN NUMBER OF BIRTHS

Period	1	2	3	4	5	6	7	8	9	10+
Before 1800	7.8	9.1	12.0	9.7	10.6	10.8	8.7	9.4	7.4	14.5
1920-1933	26.7	27.6	17.7	10.5	6.1	3.8	2.5	1.8	1.1	2.1

INDEX OF PRODUCTION OF MANUFACTURES DERIVED FROM CENSUS DATA, 1933

By Vladimir S. Kolesnikoff

The index of physical volume of production of manufactures in the United States compiled for the years 1914–1925 by E. E. Day and Woodlief Thomas [1] and for 1927–1931 by Miss Aryness Joy [2] has recently been computed for the year 1933. A description of the index was given in this Journal for December 1930. The biennial index numbers on a 1919 base for the period 1919 to 1933 compared with index of manufacturing production compiled by the Federal Reserve Board are as follows:

Year	Index numbers 1919 = 100		Per cent change from preceding census year	
	Census	F.R.B.	Census	F.R.B.
1921	79.2	78.9	....	....
1923	122.7	119.7	+54.9	+51.7
1925	128.2	123.9	+ 4.5	+ 3.5
1927	127.9	125.2	— .2	+ 1.0
1929	145.1	141.4	+13.4	+12.9
1931	96.4	95.0	—33.6	—32.8
1933	89.2	89.2	— 7.5	— 6.1

The program and schedules for the 1933 Census have been considerably curtailed and for several industries previously included in the index (Rice, cleaning and polishing; Hats, fur-felt; Oilcloths and floor coverings; Lime) no quantity data have been collected. In order to make all figures for 1919–31 comparable with 1933 it appeared advisable to revise the index numbers for previous years.

The index for the corn syrup, corn oil and starch industry has been completely reconstructed as the new series omitted in earlier years were included in this index.

The index numbers for industrial groups and for individual industries are shown in the table on the next page.

Further details will be supplied on request.

[1] Census monograph "The Growth of Manufactures, 1899–1923."
[2] This Journal, Vol. 25 (1930) p. 453 and Vol. 29 (1934) p. 305.

INDEX NUMBERS OF MANUFACTURING PRODUCTION BASED ON CENSUS DATA

(1919=100)

Industry	Index Numbers							Weights						
	1921	1923	1925	1927	1929	1931	1933	1921	1923	1925	1927	1929	1931	1933
ALL INDUSTRIES	* 79.2	*122.7	*128.2	*127.9	*145.1	* 96.4	89.2	1000	1000	1000	1000	1000	1000	1000
I. FOOD AND KINDRED PRODUCTS	* 92.6	*113.2	*118.5	*120.8	*131.5	*121.7	118.1	118	108	110	113	114	126	133
Butter, cheese and milk	104.9	122.4	131.6	145.0	150.5	149.9	145.0	* 15	13	* 12	14	13	14	15
Meat packing	90.1	113.0	105.9	108.0	113.9	108.3	107.0	* 42	* 39	* 39	* 38	* 38	* 42	42
Flour	86.9	91.1	88.2	88.1	87.0	81.1	70.1	* 23	18	18	19	18	20	22
Sugar, beet	141.4	103.7	142.3	121.7	136.1	147.6	225.2	* 4	5	* 4	4	4	4	7
Sugar, cane refining	107.1	125.8	153.7	145.6	145.3	125.8	111.8	* 6	5	5	5	6	7	7
Canned: fruits and vegetables	69.6	126.7	151.1	143.1	176.6	153.2	155.2	* 11	* 13	* 16	* 16	17	19	19
Canned: fish	47.6	71.8	95.1	106.8	146.6	82.5	90.3	2	2	2	2	2	2	2
Corn syrup, corn oil and starch	*106.6	*152.3	*155.1	*217.6	*233.4	*194.1	207.9	* 5	* 4	4	* 4	5	5	6
Ice, manufactured	112.3	128.2	143.7	144.2	162.7	154.8	121.5	10	9	* 10	11	11	13	13
II. TEXTILES AND THEIR PRODUCTS	* 96.6	*122.7	*118.5	*124.7	*130.2	*107.9	115.5	190	180	170	173	163	172	177
Cotton goods	98.6	122.8	117.2	133.2	127.9	103.3	117.7	* 79	* 76	70	* 73	* 66	* 69	73
Knit goods	94.0	115.2	112.5	115.2	130.4	113.1	121.9	* 31	* 29	* 29	* 31	* 30	* 33	34
Silk manufactures	92.6	116.9	133.8	143.2	173.8	158.9	152.1	* 29	* 26	* 28	* 27	* 26	* 28	26
Woolen and worsted goods	98.6	128.2	113.5	106.2	107.6	88.9	93.4	* 41	* 38	* 34	* 32	* 31	* 32	34
Carpets and rugs, wool	101.4	159.6	138.2	128.8	140.7	84.7	84.3	6	7	6	6	6	6	6
Cordage and twine	82.3	107.5	97.0	94.8	102.4	70.2	84.7	4	* 4	3	* 4	* 4	* 4	4
III. IRON, STEEL AND THEIR PRODUCTS	56.6	131.2	131.5	127.0	157.5	70.9	62.2	231	254	254	246	259	230	215
Blast furnaces	54.4	131.5	119.5	118.6	139.1	59.9	43.4	21	24	24	21	21	18	17
Steel works and rolling mills	56.8	131.2	132.8	127.8	159.2	71.9	64.2	210	230	230	225	238	212	198
IV. LUMBER AND ITS REMANUFACTURES	79.9	110.1	113.6	102.4	108.4	48.0	40.5	80	82	82	77	75	66	63
Lumber and timber products	79.9	110.1	113.6	102.4	108.4	48.0	40.5	80	82	82	77	75	66	63
V. LEATHER AND ITS FINISHED PRODUCTS	85.2	105.6	93.4	98.3	103.0	86.4	95.4	40	38	36	37	35	36	38
Leather, tanned, curried and finished	83.0	104.7	84.3	86.7	84.4	68.2	75.9	15	12	11	11	12	12	13
Boots and shoes	86.6	106.0	97.7	103.7	114.2	97.3	107.5	25	26	25	26	23	24	25
VI. PAPER AND PRINTING	93.4	137.1	152.5	165.7	181.3	152.7	136.1	95	90	90	98	97	108	114
Paper and wood pulp	85.2	124.3	141.2	155.3	169.0	142.2	145.1	25	25	25	27	18	19	22
Printing and publishing	96.7	141.8	156.0	167.2	181.1	151.9	128.7	65	60	60	65	74	83	85
Paper boxes	93.2	149.6	176.1	202.1	238.4	206.1	218.3	5	5	5	6	5	6	7

Industry	Index Numbers							Weights						
	1921	1923	1925	1927	1929	1931	1933	1921	1923	1925	1927	1929	1931	1933
VII. Chemicals and Allied Products	94.5	125.1	141.2	157.8	186.7	146.8	140.6	90	88	90	93	95	102	110
Chemicals and acids	84.1	119.5	135.9	155.6	204.6	163.0	163.2	18	18	19	18	19	21	24
Coke	57.1	129.0	115.7	115.2	135.0	75.5	62.1	5	8	7	6	6	6	5
Gas	98.4	112.4	113.8	129.5	128.5	117.4	98.8	14	13	13	15	14	16	18
Fertilizers	72.8	91.6	99.0	97.5	112.1	84.0	63.9	4	4	4	4	5	5	4
Explosives	80.5	114.0	108.9	108.5	104.7	69.3	57.0	3	3	3	3	2	3	3
Paint and varnish	88.4	136.0	154.8	168.2	188.0	130.3	124.5	8	8	8	10	9	10	11
Petroleum refining	120.2	162.7	203.3	240.1	316.4	275.7	258.1	25	22	24	24	27	25	29
Oil and coke, cottonseed	87.3	67.9	106.3	124.9	108.6	98.0	96.5	4	4	4	4	4	4	4
Turpentine and rosin	126.2	150.0	145.5	185.4	182.9	140.9	154.3	2	2	2	2	2	2	2
Salt	72.4	103.6	107.5	110.0	124.1	106.9	110.5	1	1	1	1	1	2	2
Soap	95.4	108.9	114.9	120.9	122.6	117.2	113.3	6	5	5	6	6	8	8
VIII. Stone, Clay and Glass Products	* 93.7	*157.5	*180.5	*176.8	*176.8	*106.3	74.8	36	36	38	36	34	33	30
Clay products	88.1	154.8	167.8	156.8	138.0	61.0	32.1	13	* 14	14	13	12	10	8
Cement	122.3	170.7	201.0	215.6	212.7	155.8	78.5	* 9	* 9	11	10	9	* 9	7
Glass	83.5	151.7	178.3	171.2	195.5	123.6	114.7	* 14	* 13	* 13	* 13	* 13	14	15
XI. Nonferrous Metals	66.5	125.7	129.8	129.7	158.5	90.5	69.6	38	40	38	40	42	39	39
Brass, bronze and other	54.6	135.1	123.6	124.2	196.4	99.7	83.2	10	10	10	10	13	12	12
Smelting and refining	61.6	113.1	124.4	126.6	131.2	74.9	51.6	8	10	10	10	8	8	7
Other industries	75.7	125.4	136.5	134.1	149.1	92.2	69.3	20	20	18	20	21	19	20
X. Tobacco Manufactures	95.3	109.8	126.5	148.5	155.0	149.0	125.1	13	12	15	15	14	18	17
Tobacco	91.3	97.3	97.6	93.4	89.9	87.5	80.7	3	2	2	2	2	3	3
Cigars	95.1	98.3	91.4	92.2	92.2	75.6	60.8	5	4	4	3	4	4	5
Cigarettes	98.1	125.6	154.8	187.9	230.4	220.4	216.2	5	6	9	10	8	11	9
XI. Vehicles for Land Transportation	73.7	195.7	218.7	145.8	210.3	83.9	73.8	33	38	43	35	38	35	31
Automobiles	87.1	227.0	272.9	177.4	281.0	122.0	98.3	26	31	37	30	32	30	30
Carriages and wagons	17.6	38.8	29.0	17.8	16.7	4.4	3.4	1	1	1	1	1	1	.1
Railway equipment	45.5	119.0	60.4	56.6	54.6	10.6	.01	6	6	5	4	5	4	.9
XII. Ship and Boat Building	30.7	7.9	7.0	8.8	8.2	7.9	1.6	14	12	10	12	12	12	12
XIII. Rubber Products	80.0	130.8	158.8	171.4	180.4	121.8	124.0	22	22	24	25	22	23	21
Tires and inner tubes	79.5	135.9	175.5	184.1	195.7	131.0	132.9	18	18	20	21	19	20	18
Boots and shoes	82.7	110.3	96.4	118.0	107.8	75.1	82.0	4	4	4	4	3	3	3

* Revised.

AN EARLY CONTRIBUTION BY LIFE INSURANCE TO VITAL STATISTICS

In considering the services which the institution of life insurance has given to the improvement of public health in the United States, it is appropriate to refer to a remarkable book published in 1857 and written by James Wynne, M.D. and entitled "Report on the Vital Statistics of the United States." * The preparation and publication of this book was made possible by the co-operation of eighteen of the principal life insurance companies in the United States. The material in the book was based upon the statistics of the Federal Government and those of the various States as well as many individual statisticians. Some of the interesting material brought out in that book is now referred to:

(a) The population of the United States was estimated over a period of 43 years in the future, and with remarkable accuracy. The method assumed an increase of population in a geometric ratio modified by the assumption that the natural increase is inversely related to the numerical density of the population in all of the States. The population in the year 1900 was stated as probably lying between 74,000,000 and 80,000,000 people. The actual population determined 43 years later was 75,995,000. At the present time officials of life insurance companies are in the forefront of the important service of estimating the population during the next 40 or 50 years in this country. The estimates generally agree in the prophecy of a stationary population in the neighborhood of 150,000,000 people at the end of such a period of time.

(b) An estimate was made of the number of unemployed persons in the United States for the year 1850. There were at that time about 2,000,000 slaves and about 20,000,000 free persons. Of the latter "the number of males above 15 years of age who were employed in different branches of industry was 5,372,000. Supposing the number of females, who in their appropriate employments are at least as industrious as the males, to be equal, then the industrious class of both sexes above 15 amounts to 10,744,000. The difference between this number and that of the whole free population is 9,244,000." From this number there were deducted 8,174,000 children under 15 years of age, 309,000 persons over age 70, 50,000 paupers, 51,000 persons in hospitals for the insane, blind, etc., 13,000 persons in prisons and houses of corrections, leaving the whole number of the idle class, 647,000 persons. "It would thus seem that the whole number of the idle class of both sexes between the ages of 15 and 70 is less than 3 per cent of the free population; and though the labor to which man is inevitably destined is occasionally excessive or irksome, yet in the main his bread is sweetened as well as moistened by the sweat with which it is earned." One of the most

* Published by Bailliere & Co., New York, London, Paris and Madrid.

important problems before the American people today is an intelligent and accurate estimate of the number of persons who are unemployed. In many ways it seems that the analysis which has just been given, written in the year 1857, is superior to some of the analyses which have been flooding our newspapers in recent months.

(c) The number of deaths in the year 1850 in the United States was given for all ages together as 324,000, of which 132,000 (41 per cent) were from epidemic and contagious diseases while 192,000 were from diseases whose cause is found within the individual attacked. The principal cause of death was consumption or tuberculosis, which accounted for 10.3 per cent of all deaths. The next principal single cause was cholera (9.8 per cent), but fevers—general, typhoid and scarlet—accounted for 12.5 per cent of all deaths. Other principal causes were dysentery (6.4 per cent), pneumonia (3.7 per cent), dropsy (3.5 per cent) and diarrhea (3.3 per cent). "It is quite certain that the deaths from both consumption and cholera have been underestimated, and probably in nearly a like proportion." Two extremely interesting things emerge from this analysis of causes of death in the United States eighty years ago. In the first place the four or five principal causes of death at that time are hardly to be found at all in a list of the principal causes at the present time. The only exception is tuberculosis, which has been so rapidly moved to an inferior position in the list of causes during the last generation. The second interesting characteristic of this comparison is that, whereas in the 1850's the summer and autumn months made up the heavy mortality, at the present time the winter and spring months have taken that place and the lowest mortality in the year is to be found in such summer months as August and September.

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NOTE ON R. CLYDE WHITE'S "SOCIAL STATISTICS"

A number of new texts have appeared recently in the field of statistics. It is only natural to find one of them written by a sociologist for the purpose of explaining how statistical methods should be used in sociology. "Social Statistics", by R. Clyde White, has been favorably reviewed in several periodicals but none of the reviewers has mentioned the unusual number of mistakes which detract seriously from the value of the book as a text and for the general reader. The carelessness of the reviewers in failing to note the prevalence of these mistakes is almost as culpable as that of the author and proofreaders.

Incorrect formulae appear in the book. For example, White gives the formula for the weighted average of relatives as: $I = \frac{\Sigma \frac{q_1 W_1}{q_0 W_0}}{\Sigma W}$ (p. 266) instead of $\frac{\Sigma \frac{q_1}{q_0} W}{\Sigma W}$. The weighted aggregate is given as $\frac{\Sigma q_1 W_1}{\Sigma q_0 W_0}$ (p. 266) instead of a formula with the same weights in the numerator and denominator. An illustration contains W_0, W_1, W_2, and W_3 as symbols of weights in different years. The subscripts 2, 3, etc., are unnecessary and awkward, for W_1 indicates variable weights which change each year. When the geometric average of relatives is used to obtain an index number, the formula results in the logarithm of the index and not the index itself as the formula on page 268 erroneously indicates.

In the chapter on time series there are a number of peculiar mistakes in method and computation. White states (p. 360):

> Seasonal indexes for these data might be computed in either of the following ways: (1) by taking the mean rate of all January rates, of all February rates, etc., after which we would have percentage figures for each month, and the total for the 12 months would be 1,200; (2) by arranging the rates for each month in an array, or a multiple frequency table, and taking the mean of the 2, 4, 6, or more middle rates; (3) . . .

Method (1) is illustrated by Table XCVI, of which the entire third column and four items in the fourth and fifth columns are incorrect. Table XCVII correcting the seasonal index for secular trend, Table XCIX showing the mean-median method, and Table C illustrating the ratio-to-ordinate method contain many mistakes of computation. In Table XCIX the correction for trend is subtracted from the index—when it should have been added as it was in method (1)—except for the November index. In the illustration of the mean-median method, there are seven months out of the twelve in which White made at least one mistake in selecting four central items out of twenty.

The quartile deviation is defined (p. 232) as "the sum of the first and third quartiles divided by 2", but the formula is correctly given (p. 233) as

$Q = \frac{Q_3 - Q_1}{2}$. Formulae for the quartiles on the same pages and the formula for the median (p. 210) should show N instead of $(N + 1)$ since no notice is taken of the fact that it is logical to expect the first item in the classes containing Q_1, Q_3, and Md to be half as far from the lower limit as it is from the value above it. The failure to recognize this situation accounts for White's failure to obtain the same value for the median by computing from the top as he obtained by computing "from the bottom upwards." White erroneously concludes (p. 211) that the difference between the two medians (for the same distribution!) is due solely to the way in which the class limits are stated. Here White refers to class interval 35–39 as 34.39 and class limit 35 as 34.

To measure skewness some authors use the formula $\frac{Q_1 + Q_3 - 2Md}{Q_3 - Q_1}$, which has the limits ± 1; others use $\frac{Q_1 + Q_3 - 2Md}{Q}$, which has the limits ± 2 (since the latter denominator is half the former). White prefers the latter formula but gives the limits incorrectly as ± 1 (p. 251).

The slope of a line is given (p. 147) in terms of the number of subdivisions ("small parts") which happen to occur on the graph paper used rather than in terms of the data presented. White confuses slope in mathematics and its equivalent in statistics where real data are used and the scales on the two axes are in different units.

White uses "trend value" to mean what is ordinarily termed the annual increase in trend values (p. 349). "Trend value" ordinarily means the complete ordinate. In discussing the measurement of secular trend, White states (p. 351) that ". . . the moving average which approaches nearest to a straight line and at the same time best fits the data is the one to use." As flexibility or the ability to measure abrupt changes in the growth of the trend values is one of the outstanding advantages of the moving average, it is misleading to say that the moving average which approaches nearest to a straight line is the best one. To fit the data adequately the moving average may have to depart radically from a straight line. Words and terms are poorly chosen. For example, "Some data show a sufficiently definite and consistent trend to justify fitting to them a mathematical instead of a moving average curve" (pp. 351–3). In a "moving average curve" the last word is unnecessary and misleading, for as White himself states (p. 353), ". . . a moving average is obviously empirical; it assumes no law of growth. But a mathematical curve is a method of stating a law of change."

White is cautious in making some statements where qualifications are unnecessary, for he states (p. 268) that the index number computed by using the geometric average of relatives "is likely to be somewhat lower, except in the base year, than the index determined by the arithmetic average." If there is any variation in the values to be averaged, the geometric average will always be lower than the arithmetic average.

Table CV illustrating the correlation of time series has some negative

"yx-Products" in the positive column and some positive products in the negative column. The total (Σxy) is a correct sum of the incorrect products, so all computations involving the sum need correction. In a second illustration, Table CVI contains an incorrect positive yx product as well as an erroneously repeated one. The total is incorrect, so r is affected.

In the chapter on Vital Statistics, Table CXIV gives the total of column (2) incorrectly and the Specific Death Rate in column (4) given as 61.1 is wrong. The computation of the geometric average (p. 223) is incorrect, as is the computation of the average deviation from the median (p. 239). Negative signs should be shown above characteristics of logarithms when they are negative. For example, none appears above the 3 on page 144. References to tables and pages are frequently incorrect; for example, substitute XCIV for XCV (p. 367), XCIX for XCIV (p. 368), p. 129 for p. 148 (footnote 5, p. 216), etc.

Turning to Chapter XI, "Measurement of Relationships", it should be noted that in simple (linear) correlation two degrees of freedom are sacrificed and not one as the formula on page 287 indicates. Table LXVIII contains two errors in the last column and the total given for this column is not the sum of either the correct or incorrect values. The computations which follow (p. 292) are affected and Table LXIX contains an additional error which affects columns z and z^2 and Σz^2. The last four columns of Table LXX contain many errors. The value for b_{yx} on page 300 is incorrect.

In the limited space of a short note all errors in the text cannot be listed or explained in detail. However, these samples or illustrations of mistakes [1] in method and computation are presented in the hope that authors of texts may be more careful, reviewers more alert, and teachers and students of statistics forewarned against the shortcomings of some textbooks.

HARRY PELLE HARTKEMEIER

University of Missouri

Professor Hartkemeier's list of mistakes in my book were known to me before he discovered them; in fact, I could mention a few more which he does not include. Obviously, there are more mistakes than such a book should have. The explanation of their presence is that pressure for time made it necessary for me to employ two persons to do most of the computations and checking. This fact, however, does not relieve me of responsibility for them. But for the most part the arithmetical mistakes do not affect the principle which is being illustrated.

His restatement of my formula for the computation of index numbers by the method of the weighted average of relatives is correct. Mine is clearly an error in proof-reading, because the computations are correct. His objection to the indication of variable weights by different subscripts merely shows his preference for the same subscript; both methods are used by competent statisticians. On p. 232 it is again obvious what my definition of the quartile deviation means, when compared with the formula on p. 233;

the definition should read, "the difference between the first and third quartiles divided by 2."

Hartkemeier says that I confuse slope in mathematics and its equivalent in statistics (referring to p. 147). There is no confusion here: I have merely used a very simple example with data to illustrate a principle. The principle is adequately illustrated, and no violence is done to the mathematics.

He is at least half wrong regarding my use of the phrase, "trend value." He says that I have used it on p. 349 to represent annual increase; I have erroneously referred to this quantity as "the annual trend value," but I have added this to a quantity in the next line to make the estimated trend value for the next year and have said so in the sentence immediately following. I do not see that this is such a serious matter. In the same paragraph he objects to my discussion of the particular moving average under discussion, because I state that the moving average which approaches nearest to a straight line fits the data best. That is a fact in this illustration, because it is obvious that these data conform to a straight line. Other illustrations of time series which I have given should be convincing that I do not assume that all such series are fitted best by a straight line.

After the above corrections are made in Hartkemeier's criticisms, it does not seem to me that, what he has left injures the book very much. The arithmetical mistakes are admitted, and they should not be in the book, but none of them does violence to a principle involved.

But what I have written above is largely a negative defense of the book. Hartkemeier's statement is wholly negative. If I may be pardoned a brief restatement of something which appears in the preface of the book, I should like to remind Hartkemeier that the only claims which the book makes to originality are three: (1) that it attempted a full-length use of sociological materials in a text-book on statistics; (2) that it introduced chapters on vital statistics and rating scales which had not hitherto been included in a general text on statistics; and (3) it published, after recomputation, for the first time in America the tables of the Chi-Function for the Pearson Chi-Test. These major objectives of the book seem to remain untouched by Hartkemeier's notes.

R. CLYDE WHITE

Indiana University

[1] None of these mistakes appeared in the short list of four errors published by White.

THE CENTRAL STATISTICAL BOARD

The Central Statistical Board, which was established by Executive Order in July 1933, under authority vested in the President by the National Industrial Recovery Act, has released its first Annual Report covering the calendar year 1934.*

The comprehensive report of the Board is quite adequately summarized by the letter of transmittal to the President, which is as follows:

April 15, 1935.

To the PRESIDENT:

I have the honor to submit herewith the First Annual Report of the Central Statistical Board covering the year ended December 31, 1934.

This Board was established by Executive order to plan and promote the improvement, coordination, and economical operation of the statistical services pertinent to the recovery program. There had long been a need for a central coordinating agency of this type for the statistical services. As early as 1908 an interdepartmental committee was established to investigate the problem. During the war an effective coordinating agency was established, but it was subsequently allowed to lapse.

The coming of the depression made the need for a statistical coordinating agency far more urgent than it had previously been. The formulation and administration of policies directed toward economic recovery and the stabilization of revived business activity brought demands for more extensive and for better organized statistical data and at the same time for a more economical conduct of statistical work. The number of Federal agencies engaged extensively in statistical work was already large in 1929; that number has since been materially increased. The Federal Statistics Board, established in 1931 with somewhat limited powers and without a staff, was inadequately equipped to cope with the problem, and in August 1933 it was replaced by the Central Statistical Board, five members of the old Board becoming members of the new Board.

During the year and a half since its establishment the Central Statistical Board has been able to record continuing and substantial accomplishments in the coordination, improvement, and economical operation of the statistical services.

The Board's attention during the first 6 months after its establishment was largely occupied with problems of an emergency nature, which were referred to it by Federal statistical agencies and which urgently demanded attention. Important as this work has been, the Board has felt from the start that if it is to perform its functions adequately it should not confine

* A limited number of copies is available for distribution upon request to the Board, 7028 Commerce Building, Washington, D. C. A sales edition also is available from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 10 cents.

its activities exclusively to more or less isolated problems raised by the several statistical agencies, but must in an advisory role assume the initiative in planning and promoting the improvement, coordination, and economical conduct of statistical work. Accordingly, during the past 12 months it has devoted itself increasingly to problems in which it has taken the initiative, on the basis of experience gained in the course of its operations since the summer of 1933. In this, its First Annual Report, the Board suggests general principles for the long-range development and improvement of the statistical services, and reviews its own operations and the progress of statistics during the past year.

Statistical problems originating with the several Federal statistical agencies are brought to the Board's attention through its reviews of plans for statistical inquiries, through its reviews of statistical releases, through requests of a more general nature addressed to it by statistical agencies on their own motion, and through personal contacts by members of the Board and its staff.

Some 200 statistical inquiries projected by different statistical agencies of the Government have been reviewed while in the planning stage. Through these reviews the Board has accomplished:

1. *Important economies.*—Elimination of unnecessary inquiries and decrease in the number of respondents canvassed have resulted in savings conservatively estimated at several million dollars. Duplicate inquiries have been avoided by coordination of mailing lists.
2. *Better information.*—More careful planning of inquiries has been encouraged. Extensive and continuing technical assistance has been given on several inquiries, including the financial survey of urban housing, the farm housing survey, the census of manufactures, the census of agriculture, and the trial census of unemployment.
3. *Coordination of work.*—Wider serviceability of inquiries has been promoted through committees and conferences of the Board, all interested agencies being thus afforded opportunity to make suggestions to the agency conducting a particular inquiry. Comparability of data collected by different agencies and of their classifications has also been improved.

In response to a resolution of the Executive Council in November 1933, the Board has reviewed approximately 300 current or special releases for the press which are statistical in nature. This review service has encouraged statistical agencies to check their findings with each other, has promoted a higher standard of accuracy in reporting data and in explaining methods and sources, and has avoided inadvertent contradictions of statements on the same subject.

The most important single special request which has come to the Board was for an extensive survey of the work of the Bureau of the Census. On part of this survey the Board has had assistance from the Civil Service Commission. Although the work is still in process, final recommendations on certain important phases of Bureau organization, and on personnel administration, cost accounting, and job analysis have gone forward and are in process of adoption.

Other administrative problems with which the Board has been concerned include: The organization of a division of research and statistics in the

Public Works Administration; the consolidation of two statistical units concerned with the mineral industries; the organization of statistical work in the Federal Housing Administration; and changes in the organization of the Division of Employment Statistics of the Bureau of Labor Statistics.

During 1933–34 the Board made recommendations for financing the maintenance of several statistical services providing information essential for the recovery program. In order that it might be better equipped to advise on budget problems hereafter the Board has since that time been collecting information on the costs of various statistical services.

In conformity with the general policies developed during the period of the Board's operation a number of improvements in statistical information have been made which the Board has helped to promote. They include:

1. The provision of better wholesale and retail current price data through improved specifications for reporting, and in the retail field in particular, through the addition of new commodities and through enlargement of the list of firms from which price data are gathered.
2. The revision of current monthly indexes of pay rolls and employment in industry and trade, and the improvement of the coverage in a number of lines of business poorly represented previously.
3. The establishment of a complete current monthly report on Federal pay rolls and employment.

The Board is now working on a number of further projects for better statistics. The most important of these is a cooperative arrangement for improved current business statistics involving the National Recovery Administration, the Bureau of Labor Statistics, the Bureau of the Census, and the Bureau of Foreign and Domestic Commerce. It is proposed to coordinate current reports on pay rolls, employment, merchandise stocks, and production (or sales) for industries under codes, consolidating current report forms and establishing comparability of data in various industries. The development of representative coverage in the construction industry and in retail trade is also being advanced.

Other projects on which the Board is now working include:

1. A plan for an improved census of unemployment to be taken together with a census of occupations and population.
2. Refinement of current estimates of employment and unemployment.
3. A plan for reorganizing information on State and local public finance.
4. Coordination into a unified program of family expenditure studies by three Federal agencies.
5. Experimental inquiries conducted by cooperation of four Federal agencies in the field of real property and construction statistics.

The Board is in process of organizing a statistical clearing house to promote coordination of statistical work. It will include: (1) A directory of the Federal statistical services (already published); (2) an extensive file (already partly assembled), describing important statistical series, which will be available for the use of all Government agencies; (3) current records on the progress of statistical inquiries; (4) current records on available tabulating machines in the Federal service.

The place of these projects on which the Board has been working, in a rounded program of statistical information, is set forth in the First Annual Report. The problem of coordination and improvement of statistics is a continuing one, and many of the changes in information now clearly needed as a basis of forward-looking public policy will require effort continuing over a period of years. At present the Board is authorized as an emergency agency, but it has endeavored to discharge its functions with full recognition of their longer-range significance.

The Board attributes the considerable success that it has been able to enjoy to its cooperative constitution, and to the fine spirit of cooperation that has prevailed among Federal statistical agencies. In view of the progress that has been made in the coordination and improvement of statistical work during the past year and a half, the members of the Board, representing the various Federal statistical agencies, feel warranted in asking a statutory authorization for the Board. They believe that statutory authorization for a continuing Board consisting of qualified persons chosen from the statistical services and serving without additional remuneration will not only assure a continuation of the progress already made, but will also make possible a more effective performance of the functions now assigned to the Board than has been achieved thus far.

The Board has given careful thought to the form which such authorization should take. It is unanimously of the opinion that statutory authorization at the present session of the Congress along the lines set forth in the First Annual Report is urgently needed.

Very respectfully,

JOHN DICKINSON,
Acting Chairman.

A bill which establishes the Board as an independent agency of the Federal Government for a further period of five years was approved by the President on July 25, 1935.

PROGRESS OF WORK IN THE CENSUS BUREAU

Reorganization of the Division of Vital Statistics

The reorganization of the Division of Vital Statistics, described on another page of the JOURNAL, will, it is believed, mark the beginning of a new advance in the development of vital statistics in the United States. It will, of course, take time—a good many years, doubtless—to bring about all the improvements that have been projected or contemplated in this branch of the Bureau's work. The situation is complicated and rendered more difficult by the fact that the Bureau must rely upon the voluntary cooperation of 48 independent state health offices to provide satisfactory and complete basic data for the statistical compilations which form the content of vital statistics. It is evident from the letter of the Director (printed on page 597) that he counts confidently upon the cooperation and support of the members of the American Statistical Association in building up and improving the work of the vital statistics division.

A New Division

In connection with the change in the vital statistics division and partly as an outcome of it, a new division has been created—the Division of Religious Statistics, General Information and Records. This division will have charge of the census of religious bodies which is to be taken next year; and it is proposed that this census, which is now taken only once in ten years, shall be taken every five years hereafter. The new division will also have general charge of the printing and distribution of census publications, and of the preservation, filing, and indexing of census schedules and other statistical records in possession of the Bureau but not being needed or used for current tabulations.

Use of Census Records

Besides the original schedules and the punched cards, the census records referred to above include numerous manuscript tables produced at various stages in the process of tabulation and containing a mass of statistical detail not reproduced in the final published tables. For instance, all the population detail that is shown for a state in Volume III of the Fifteenth Census Reports on Population is available in manuscript for every county in the state; and for every city of over 2,500. But only a small part of this information can be included in the published tables giving statistics by counties and for cities. It has been estimated, indeed, that not more than one-tenth of the population detail obtained by the combining and recombining of data during the process of tabulation actually appears in the printed reports of the census.

There is a growing demand both from the various agencies of national, state, and local governments, and likewise from private organizations, insti-

tutions, corporations, and individuals for information which, though obtainable from census records, has never been published. In almost all cases the greater part of the cost of procuring the information has already been met. For example, the Bureau has recently supplied to the Committee on Economic Security at a cost of $2,000 certain tabulations of family data in Pennsylvania and Georgia which, it was estimated, would have cost approximately $1,500,000 to procure by means of an original field inquiry.

The Bureau of the Census is not equipped to supply this information free of cost. Moreover, in many instances the information desired is not of general interest but is of value only for the very limited purpose for which it is requested. To meet this situation a provision was inserted in the Census Act of 1919 authorizing the Director "to furnish transcripts of tables and other records and to prepare statistical compilations for state or local officials, private concerns, or individuals upon payment of the actual cost of such work." Under this provision numerous special tabulations have been made for government agencies, civic or business organizations, and private corporations or individuals—small jobs most of them, but including, now and then, a fairly large undertaking.

To give some recent instances:

The National Bureau of Economic Research requests a tabulation of the actual value or rental of homes in selected cities, villages, and towns. This tabulation covered approximately 260,000 families (Cost $1,000).

The Life Insurance Company of Virginia requests a tabulation of population by sex and 5-year age periods for the group of cities having from 2,500 to 10,000 inhabitants and likewise for that having 10,000 and over, in 15 states. (Cost $90).

The University of Pittsburgh requests steel works and rolling mill production of specific products, by degree of integration, and by types of companies (Cost $200).

The American Paper and Pulp Association requests statistics of capacity production, value of products, number of wage earners, and total wages, for 450 paper mills, classified upon rated capacity and on chief products manufactured (Cost $100).

It is the policy of the Bureau to grant the requests for special tabulations wherever practicable and not in violation of the provisions of census law against the publication of data whereby a particular establishment or individual can be identified or the furnishing of information that may be used to the detriment of the person or persons to whom it relates.

The importance of the population schedules as records is by no means limited to their usefulness as a basis for statistical compilations. They are constantly being consulted to establish the ages of pensioners or applicants for pensions, or of children seeking employment, or to obtain data wanted in genealogical research, or information required for securing pass-

ports, or for establishing citizenship or other purposes. The supplying of this kind of information is a branch of the Bureau's work which was wholly unanticipated when the permanent Bureau was organized in 1902. It has expanded greatly in recent years especially with the enactment of laws providing for the old age pensions. The number of searches made in a year has increased from about 3,000 in 1922 to over 18,000 last year; and the present force of 30 clerks employed on this work has difficulty in keeping it up to date. To a large extent the Bureau is supplying a class of data which, if this country had always had an adequate and complete system of birth registration, would be available in the state or other local registration offices.

The policy of the Bureau is to furnish freely personal data concerning the person who makes the request, but not as a rule to supply similar information relating to other persons. The population schedules for censuses prior to that of 1880 may, however, be freely consulted and drawn upon by the public for genealogical, historical or other purposes.

Census Tracts

The growing realization in recent years of the desirability of being able to tabulate the statistical data for any city by small permanent subdivisions has resulted in the establishment in many cities of census tracts, which may be defined as small areas comprising, as a rule, a population of from 3,000 to 8,000, into which a city is subdivided more or less arbitrarily for statistical and local administrative purposes. The tracts are permanently established so that comparisons may be made from year to year and from census to census. They are laid out with a view to approximate uniformity in population and with some regard for uniformity in area; and each is designed to include an area fairly homogeneous in population characteristics.

The movement for the establishment of permanent areas for statistical purposes had its beginning in the city of New York, where it was initiated and carried out by Dr. Walter Laidlaw, Executive Secretary of the Cities Census Committee existing at that time.

Prior to the census of 1910 tracts had been established for Chicago, Philadelphia, Cleveland, St. Louis, Boston, Pittsburgh, and New York City; and the population of these cities was tabulated in some detail by tracts both in 1910 and in 1920. In the census of 1930 tabulations were made by tracts for 18 cities, including the seven mentioned above, and, in addition, Los Angeles, Buffalo, Baltimore, Washington, Cincinnati, Indianapolis, Columbus, Nashville, Berkeley, Syracuse, and Yonkers. The tabulation included classifications of the population by color, nativity, sex, and age; of the foreign-born white population by country of birth, and of the native white population of foreign or mixed parentage by country of birth of parents; of gainful workers by industry groups; of families by size (number of members) and by color and nativity of head; and of homes by tenure and value or monthly rental.

The cost of the tabulation in each instance was borne by some civic

organization or some branch of the city government in the city for which the tabulation was made. The figures are used directly in many ways both by city departments and welfare organizations and by commercial concerns, such as newspapers, utility companies, and selling organizations. But their greatest value is probably brought out when they are made to serve as a background for material collected locally, such as the records of deaths, contagious diseases, and juvenile delinquency; and also, at the present time, of unemployment relief and other emergency activities.

Since 1930 the tract idea has been steadily growing in favor; and at the present time tracts have been established or are in the process of being established by local organizations for all of the 37 cities having more than 250,000 inhabitants, except Memphis and Toledo, and also for five smaller cities, namely, Nashville, New Haven, Richmond, Syracuse and Yonkers. The census tracts in all these cities were laid out by committees representing local organizations and working in cooperation with the Bureau of the Census. Several of these cities of their own initiative have extended the tract division to cover the suburban territory.

In 1931 the American Statistical Association appointed a committee on Census Enumeration Areas. This committee, under the chairmanship of Howard W. Green, of Cleveland, has devoted its attention to a study of the tract plan, submitting several reports on that subject, and has been actively cooperating with the Census Bureau in promoting the establishment of tracts by the principal cities of the country.

The Census Bureau has recently published a manual [1] on Census Tracts, a copy of which may be obtained without charge upon application to the Bureau.

J. A. H.

VITAL STATISTICS IN THE CENSUS BUREAU

July 1, 1935.

To Those Professionally Interested:

As Director of the Census I am adopting this method of announcing a reorganization of the Division of Vital Statistics of the Bureau of the Census to those who are professionally interested. For approximately one-third of a century the fundamental task of the Bureau in this field was to extend the registration areas for births and deaths. With the completion of both areas by the admission of Texas in 1933, this primary responsibility was ended. The period since that time has been one of transition, in which we have sought to appraise and prepare for the new types of work for which we must now become responsible. We have realized that new tasks must be undertaken while past gains were preserved and consolidated.

[1] Census Tracts in American Cities. A Brief History of the Census Tract Movement, with an Outline of Procedure and Suggested Modifications. By Howard Whipple Green and Leon E. Truesdell (14 pp. mimeographed).

In 1933, the Joint Advisory Committee of the Director of the Census took steps to explore the various questions and problems involved. Its inquiry resulted in a report to the Director on January 17, 1935. This report calls attention to the great opportunity for the development of vital statistics in this country. It asserts:

> "Country-wide registration furnishes comprehensive data for the first time. While it is still necessary to work for more complete and accurate recording of the facts as to births and deaths, new and intensive efforts can be devoted now to analytical treatment of the data and to the presentation of more refined results. A better statistical basis for public health work will be laid, and for all studies of population structure and changes.
> "The United States is in about the same situation as England was in the last century when William Farr began his studies and publications, which placed his country in the position of unchallenged leadership in the public health movement."

Continuing, the report points to a number of specific "problems in vital statistics which press for solution", analyzes the qualifications of the personnel which should be entrusted with these problems, and concludes with detailed recommendations to the Director.

This report and its recommendations have been approved by the Director and the Secretary of Commerce. The reorganization now under way is the result. It is our immediate purpose to place new supervisory personnel in charge of each of three important types of functions within the Division.

Heading the Division as Chief Statistician will be Halbert L. Dunn, M.D. (University of Minn.), Ph.D. (Minnesota, in anatomy), Director of the University Hospitals and Professor of Medical Statistics in the University of Minnesota Medical School. Dr. Dunn was a former director of the statistical work of the Mayo Clinic at Rochester. In addition to his general supervisory responsibilities, Dr. Dunn will have direct charge of the research and analytic developments for which the report of the Advisory Committee calls. He will assume office on or before July 12, 1935.

As Assistant Chief Statistician of the Division, the Bureau has appointed John Collinson, M.D., D.P.H. (both Johns Hopkins), who has resigned his positions as Registrar of Vital Statistics for the State of Maryland and Secretary of the American Association of State Registration Executives. Dr. Collinson will be in immediate charge of the development and perfection of registration and of relations with state health officers and registration officials.

The Bureau is now negotiating for the appointment of a Technical Assistant to the Chief Statistician for Vital Statistics who will have immediate charge of the classification and coding of causes of death, the development of the Joint Manual, representation of the Division respecting changes in the International List, and relations with medical schools and the medical profession.

The Chief Statistician will be especially assisted in the development of this program by Forrest E. Linder, Ph.D. (University of Iowa), whose scientific training and publications have been in the fields of psychophysics, biometrics,

social and abnormal psychology. Dr. Linder resigned a position with the Worcester (Mass.) State Hospital to take office in the Bureau on June 1, 1935.

The Division's budget for the coming fiscal year likewise provides for the appointment of six field agents who will represent it in maintaining direct contacts with state officials. A districting of the United States for this purpose is contemplated. It is hoped to obtain for these posts, with the cooperation of the Civil Service Commission, well-qualified young men of scientific and medical training.

These changes have permitted the assignment of the present Chief Statistician, and the former Assistant Chief Statistician of the Division of Vital Statistics to other important functions within the Bureau of the Census. On or before July 12, 1935, Dr. T. F. Murphy will become Chief Statistician of the newly-established Division of Religious Statistics, General Information and Records. In this position he will be responsible not only for the forthcoming decennial census of religious bodies, but in addition for the development of the Bureau's too-much-neglected services of information to the public, and for its public relations generally. Mr. Willard C. Smith has been promoted, at higher grade and salary, to the post of Assistant Chief Statistician of the Division of Population, where he will bear much of the burden of the projected 1935 census of population, unemployment and occupations, and of developing the Bureau's activities in the population field in anticipation of the decennial inquiry of 1940.

The foregoing changes accompany others now taking place or in prospect in various Divisions of the Bureau of the Census. They are motivated by considerations of public service, scientific progress, and merit as a guide to the selection of personnel. It is our ambition to build up the Bureau to a point where it may without challenge be regarded as the best, as it is now the largest, statistical organization in the world. The Bureau will endeavor to merit support for its program, and we eagerly hope that readers of this announcement will continue to favor us with their confidence and cooperation.

Very sincerely yours,

W. L. AUSTIN, *Director.*

THE INTERNATIONAL STATISTICAL INSTITUTE

The "Committee to Arrange for a Meeting of the International Statistical Institute in the United States in 1939," which presented a report at the last annual meeting of the American Statistical Association (this JOURNAL, XXX: 326) is now able to report further progress.

The following joint resolution has been passed by the Senate and recommended to the House of Representatives by its Committee on Foreign Affairs:

> Whereas the American Statistical Association will celebrate its centenary in 1939; and
>
> Whereas it desires to invite the International Statistical Institute, an international organization with similar objectives, to be its guest at that time; and
>
> Whereas for fifty years the Institute has met on invitation from the Government of the country in which the meeting occurs: Therefore be it
>
> *Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,* That the President be, and he is hereby, requested to extend to the International Statistical Institute an invitation to hold its twenty-fourth session in the United States in the year 1939.

E. Dana Durand
Haven Emerson
Walter F. Willcox, *Chairman*

The invitation for which this resolution is the initial step will be presented at the 23rd session to be held at Athens, Sept. 27–Oct. 3, 1936. A meeting of the Bureau, or executive committee, Messrs. Friedrich Zahn, Walter F. Willcox, Michel Huber, Armand L. L. A. Julin, Franco Savorgnan, Henri W. Methorst and Arthur L. Bowley, will be held at The Hague Aug. 21 and 22, 1935, to make arrangements for that session.

The American members of the Institute are: Honorary—Herbert C. Hoover, Walter F. Willcox; Regular—William L. Austin, Edmund E. Day, Davis R. Dewey, E. Dana Durand, Richard T. Ely, Haven Emerson, Roland P. Falkner, Irving Fisher, Worthington C. Ford, Joseph A. Hill, Wesley C. Mitchell, Charles P. Neill, William F. Ogburn, Raymond Pearl, Warren M. Persons, Stuart A. Rice, Joseph Schumpeter, Carl Snyder, William M. Steuart, Edgar Sydenstricker, and Edwin B. Wilson.

NOMINATING COMMITTEE

In accordance with the provisions of the Constitution, President Willford I. King has appointed a Nominating Committee to make nominations for officers to be elected at the next Annual Meeting. The members of the Committee are Warren M. Persons, *Chairman,* Irving Fisher and E. Dana Durand.

Frederick F. Stephan, *Secretary*

CHAPTER ACTIVITIES

THE ALBANY CHAPTER.—During the past winter the Albany Chapter of the American Statistical Association has held five meetings, with an average attendance of 37. Two of the meetings were given over to general discussions of service record ratings and classification of statistical workers in the State Service. Representatives of the Civil Service Department took an active interest in these meetings and encouraged the Chapter's committees in making a rather thorough study of these subjects. One session was devoted to the question of Insurance with two of our members who are in this department carrying the program.

The feature meeting of the year was held jointly with the Albany Chapter of the National Association of Cost Accountants. At this meeting Dr. Willford I. King, President of the American Statistical Association, delivered an address entitled, "Are We Menaced by Inflation?" At this meeting, Mr. W. F. Collendar, Chief of the Crop Reporting Section of the United States Department of Agriculture, Bureau of Agricultural Economics, was a guest.

A decision was reached by the group to have the new officers take charge at the end of the winter meetings, rather than at the end of the year. As a result the following officers were elected on May 7th: President, Dr. Warren W. Coxe; Vice-President, Miss Elizabeth Parkhurst; Secretary-Treasurer, Dr. R. F. Bucknam; and Members of Executive Committee, Dr. David M. Schneider and Mr. Julian M. Gibson.

The season's activities closed with a picnic at the summer home of Dr. Horatio M. Pollock, the first President of the Chapter.

THE CHICAGO CHAPTER.—At the annual meeting of the Chicago Chapter of May 22, the following officers were elected for next year: President, John W. Boatwright, Statistician, Standard Oil Company of Indiana; Vice-President, Harland H. Allen of Harland Allen Associates; and Directors, Professor John H. Cover of the University of Chicago, John H. Noble of Armour and Co., and Gilbert Gusler of the Agricultural News Service. The annual reports of the officers and committee chairmen indicated that the results of the past year were quite satisfactory. Six dinner meetings were held during the year, at which ten addresses were heard, with an average attendance of fifty-five. Paid memberships for the year totaled seventy-three.

At the last meeting of the year, the speakers were Dr. Donald R. G. Cowan, Commercial Research Department, Swift and Company, who spoke on "Sales Quota Determination," and Professor James L. Palmer, University of Chicago, who discussed "Practical Problems of Budgeting Sales." Dr. Cowan discussed the evolution of the methods of quota determination and the nature of various factors affecting sales. In conclusion, he stated that the basis of quota determination has broadened from one or two narrow assumptions to a complete consideration of all pertinent business tendencies. Philosophically, it has been a shift in emphasis from deductive to inductive

reasoning but both are, of course, necessary. Professor Palmer discussed some of the more practical aspects of the application of budgeting procedure. During his talk, he developed the following points, among others: the more detailed the planning the less accurate are the estimates; budgeting should, in general, involve only items which can usually be forecast accurately; budget systems must be custom built; and budgeting can be successful only if recognized by the executives as an integral part of management.

THE CLEVELAND CHAPTER AND THE OHIO CONFERENCE OF STATISTICIANS.—The eighth annual meeting of the Cleveland Chapter was held on Friday, May 3, jointly with the annual meeting of the Ohio Conference of Statisticians in the club rooms of the Cleveland Chamber of Commerce. Mr. Ernest F. Du Brul of Cincinnati was chairman of the morning session of the Ohio Conference of Statisticians. Three papers were presented. Mr. R. E. Davis, manager of the Commercial Research Department of the Goodyear Tire and Rubber Company in Akron, spoke on "Statistical Trends in the Tire Industry." Mr. David C. Elliott, chief of the Statistical and Economic Division of the Reconstruction Finance Corporation in Washington presented a paper entitled, "Loans to Industry." Mr. Stephen M. Du Brul of the General Motors Corporation in Detroit spoke on the "Principles and Their Application to Stabilization of Automobile Employment."

Mr. Charles J. Stilwell, president of the National Association of Machine Tool Builders, was chairman of the luncheon meeting of the Conference at which a talk was given by Dr. A. J. Hettinger, Jr. of Washington on "Problems and Prospects of the Heavy Goods Industries."

Mr. John W. Love of the Cleveland Press, president of the Ohio Conference, was chairman of the afternoon session. A paper, "The Income Study of the Department of Commerce" was presented by Dr. H. Gordon Hayes, chief of the Division of Economic Research, the Bureau of Foreign and Domestic Commerce. Mr. Howard Whipple Green of Cleveland spoke on the "Income and Economic Status of Typical Cleveland Market Areas." Dr. Spurgeon Bell, chief of the Division of Research and Statistics of the Federal Home Loan Bank Board addressed the Conference on "The Market for Real Estate Mortgages and Its Bearing on a Revival in Construction." Prof. L. F. Hampel of Akron University spoke on "Pictorial Statistics."

At the dinner meeting in the evening, the Cleveland Chapter elected the following officers for the coming year: president, Mr. D. A. Hill of the Ohio Public Service Corporation; vice-president, Mr. L. M. Whittington of the Van Sweringen Company. Mr. Whittington presided at the evening meeting. The Chapter was fortunate in having as a guest, Dr. David Friday, who offered a few words of encouragement to regional statistical meetings. Mr. Clark L. Mock, director of the Cuyahoga County Relief Administration spoke on "Relief Trends." Mr. Frederick F. Stephan, secretary of the American Statistical Association addressed the Chapter on "New Areas of Statistical Activity." The last speaker was Col. Leonard P. Ayres, vice-president of

the Cleveland Trust Company. Col. Ayres presented a review of his pamphlet, "The Chief Cause of This and Other Depressions."

A meeting of the Business Statistics Group of the local chapter was held on May 10. Mr. Munson Havens, executive secretary of the Cleveland Chamber of Commerce spoke informally on his observations of the annual meeting of the U. S. Chamber of Commerce.

THE CONNECTICUT CHAPTER.—Since the last report in the JOURNAL the Connecticut Chapter has had three general meetings. In January, Mr. Paul Burnham of the Department of Personnel Study, Yale University, gave an interesting talk on "Forecasting Educational Aptitude." At a well attended dinner meeting at the University Club in Hartford in February, Mr. W. R. Williamson of the Travelers Insurance Company, consultant to the Committee on Economic Security in Washington, discussed "The Statistical Background of Unemployment Insurance." After a dinner in New Haven in March the Chapter adjourned to the local offices of the International Business Machines Corporation where a moving picture of "Taking the Census" was shown. Professor Theodore Brown of the Harvard Business School read a paper on "Correlation and Association," and a demonstration of business machines was given. The Business Section of the Chapter continued its monthly meetings for discussion of the current business situation. In March the Business Section sponsored an open dinner meeting at which Mr. Blanchard of the Bullard Company of Bridgeport discussed "The Outlook for Durable Goods Manufacturing."

NEW YORK DISTRICT CHAPTER.—More than four hundred members and guests attended a dinner meeting of the New York District Chapter on April 26, 1935. The general topic of the meeting was "Unemployment, Capital Supply, and the Theory of Depressions." Dr. W. Randolph Burgess, Deputy Governor of the Federal Reserve Bank of New York, introduced the speakers.

The first speaker was B. M. Anderson, Jr., Economist of the Chase National Bank, who spoke on "Money and Credit in Boom, Crisis and Depression." His paper, which has been published by the Chase National Bank, was a critical analysis of Lauchlin Currie's book "The Supply and Control of Money in the United States." Dr. Anderson stressed the importance of the book arising out of the connection between the theories that it contained and pending Federal banking legislation. He criticized Currie's quantity theory of money as "exceedingly unrealistic" and "incredibly naïve" in the application of a simple mathematical formula to the complexities of economic life. The speaker stated that Currie's contention that interest rates and the volume of demand deposits are inversely associated is erroneous and that his views on commercial loans, liquidity of bank assets, and other points were counter to accepted principles of banking. He pointed out misunderstandings and inaccuracies of fundamental facts and declared that any simple theory purporting to explain money and credit was wrong.

Professor B. H. Beckhart of the Columbia University School of Business

discussed Dr. Anderson's paper and on the whole agreed with his theoretical approach. In the control of credit, he stated that emphasis should be placed on qualitative rather than quantitative analysis. In explaining business fluctuations in terms of changes in the supply of money, the quantitative theorists neglect the effects of additional increments of credits upon particular prices, the inflationary consequences of a deterioration in the quality of bank assets, the absolute need at times of credit liquidation. He concluded by stating that every effort should be made to restore liquidity to the portfolios of the Federal Reserve Banks and of member institutions.

The second speaker was Dr. Willford I. King, President of the American Statistical Association, who spoke on "Unemployment and Wage Rates." He observed that the New Deal was substituting wishes for facts, an evidence of which was its attitude toward appropriation of five billion dollars for work relief, resting on the idea that the unemployed are victims of misfortune and should be cared for. Dr. King noted that unemployment rates are high in prosperous countries and low in countries where wages were also low. He pointed out that the law of supply and demand covered prices including the price of labor. He quoted studies by Gardiner C. Means and the National Recovery Administration which showed that production kept up if prices were flexible and concluded that we have a choice between stability of prices and stability of employment. Employment and production could be maintained if prices dropped, but fixed wages and relief have prevented employment.

"Capital Supply and Industrial Growth in the United States" was discussed by Mr. Carl Snyder, Statistician of the Federal Reserve Bank of New York. He traced the development of the Ford Motor Company as an example of the fact that industry has generally supplied its own capital. By means of charts, he portrayed for manufacturing as a whole and for several major divisions, the long-time growth in the amount of capital invested, the value of their products and related factors. In these he showed not only the rapid increase of total industry during the last century, but also the characteristic growth of types of manufactures and especially the close relationships that exist between the amount of capital invested and the value of the products, in each group as well as in all manufacturing. He explained that this growth has been financed by a relatively small number of people who are still in control of industry, and concluded that the supply of capital must be maintained if the United States is to be a prosperous and employed nation.

Professor Lewis Haney of New York University spoke on "The Price System in Relation to Unemployment and Depression." He declared that business men could not plan because they were no longer able to forecast with confidence. That, in turn, is because the price system is not working. He insisted that in order to allow the price system to work money must have an objective value, and that profit opportunities must be restored. He pointed out the maladjustment of prices, and listed as false notions the following: that unemployment is the cause of depression, that there is not enough money, the quantity theory of money, that currency inflation is worse

than credit inflation, and that durable goods are different from consumers' goods. He held that the only sound way to recovery is deflation, but thought recovery unlikely in the near future.

Colonel Leonard P. Ayres, Vice-President of the Cleveland Trust Company, discussed the "Relationship of Unemployment to the Cause of Business Cycles." After indicating that the depression was the offspring of the Great War, he pointed out that unemployment was its most significant feature and that of the two major groups of unemployed workers, producers of services were unemployed largely because of the unemployment of the producers of goods. He showed by several new and interesting charts that employment of producers of consumers' goods was relatively stable and employment of producers of durable goods relatively fluctuating over the last fifteen or twenty years. The amplitude of fluctuation for the latter group was about three times that for the former group. A comparison of the upturns and downturns showed that consumers' goods did not consistently lead or lag behind durable goods. Consequently, the popular theory that turns are initiated by changes in consumer purchasing power was not substantiated. On the contrary, business cycles are largely caused by or related to changes in the purchase of durable goods. Durable goods are purchased for the most part by business concerns and business cycles are largely caused by fluctuations in the purchase of durable goods actuated by the changes in the prospects for profits.

THE PHILADELPHIA CHAPTER.—On June 7, 1935, at the last meeting of the chapter year, the Philadelphia Chapter discussed "Statistical Aspects of Social Security." Professor C. A. Kulp of the University of Pennsylvania gave a careful analysis of the Wagner-Lewis-Doughten Bill, pointing out the extraordinary difficulty of making an estimate of the risks involved on any actuarial basis and stressing the complication growing out of the proposed piling up of enormous reserves, particularly in connection with the old age section of the Bill.

Dr. Ewan Clague, Director of Research at the Community Council, spoke on "Some Quack Remedies for Social Insecurity," paying his respects to Huey Long, Townsend, Father Coughlin and the Lundeen unemployment insurance proposal. In indicating some of the fantastic suggestions brought forward, the speaker stressed the extraordinary political pressure behind some of these groups.

A general evaluation of "The Quest for Security" in America and Europe was made by Dr. E. M. Burns of the Department of Economics, Columbia University. After indicating the usual arguments for social insurance system, she pointed out how differently the situation had worked itself out in various European countries and indicated that social insurance is no panacea for social and economic ills. Part of the confusion has grown out of the use of the term "insurance," social insurance being thought of in terms paralleling those of individual insurance which is unfortunate. Social insur-

ance has behind it government compulsion and the government power to tax in order to meet deficits, and consequently is an entirely different thing from private insurance.

Dr. Burns also stressed the fact that social insurance to be successful must be part of a larger program of handling distress and need. The secondary reserves behind the wall of social insurance must be an adequate national system of care for those in distress since any system of social security involves using up the reserves of any one individual. Thus under the usual unemployment insurance scheme after twenty-six weeks a man's protection is exhausted.

One of the principal problems of social insurance is the question of how the money shall be raised to finance it. Many people have stressed the desirability of securing this money from employers and employees. However, in the last analysis, it is a practical matter and it may well develop that such funds can be more adequately secured from general taxation rather than payroll taxes prorated to employer and employee. Dr. Burns also stressed that on the basis of European experience once a country has started down the road of social insurance, it is very hard to turn back and that we may expect that the country will continue as England has done from time to time to enlarge and modify its social security program.

THE PITTSBURGH CHAPTER.—At the April meeting of the Chapter, Mr. Frederick F. Stephan, Secretary-Treasurer of the American Statistical Association, spoke of "Statistics as a Basis for Action." The address was an interesting recital of observations of the constructive use being made of statistics by the many concerns and individuals he visited on a recent trip. Since this meeting a committee of the Chapter has been working out a program of statistical activities for the Chapter.

The May meeting was addressed by Dr. Charles S. Tippetts, Dean of the School of Business Administration, University of Pittsburgh. His discussion of "Recovery Measures in Other Countries" was very enlightening and entertaining.

Dr. Glenn E. McLaughlin, Industrial Economist, Bureau of Business Research, University of Pittsburgh, made some surprising disclosures at the June meeting about "The Growth of Population and of Manufacturing Employment in the Pittsburgh Industrial Area." Dr. McLaughlin discussed the subject authoritatively and presented the results of extensive research on the subject.

THE SAN FRANCISCO CHAPTER.—The San Francisco Chapter of the American Statistical Association met on May 2, in the Bellvue Hotel, San Francisco to hear Dr. Alonzo Taylor, Director of the Food Research Institute, Stanford University, on "The Facts of the World Wheat Situation." Thirty-three members and friends of the Association were present.

Dr. Taylor pointed out that wheat is not a single commodity, but a group of commodities with quite inelastic demands and differing types of utilization.

He discussed in detail the difficulty of securing accurate statistics on acreage, yield, condition, utilization, carry-over and other important aspects of the wheat situation. The available statistics are usually less accurate than many people assume them to be. Export trade is influenced by many factors, including fluctuations in prices and shipping rates. Forecasting exports is of tremendous value in export trade, but difficulties arise when the forecasts deviate widely from actual exports. The problem of controlling the wheat prices of the world is still unsolved.

WASHINGTON STATISTICAL SOCIETY.—On May 9, 1935, the Washington Statistical Society had a dinner meeting on the general topic "Recent Developments in Governmental Economic Statistics." Dr. E. Dana Durand, Chief Economist of the U. S. Tariff Commission, presided. He also made a short statement about the work of the International Committee of Statistical Experts (appointed under the International Treaty on Economic Statistics of 1928) in developing an international classification of commodities for export and import statistics.

The first speaker was Dr. Stuart A. Rice, Assistant Director of the Bureau of the Census, who discussed the proposed unemployment census. Dr. Rice outlined a plan for trial enumeration in six localities and sketched the scope of a census which would include population, employment and unemployment. He pointed out the need for a special census in terms of recent changes in the direction of migration, the demand for an accurate population base for use in research and administration, the lack of necessary information about population and employment for the guidance of Federal activities in relief, public works and resettlement, and numerous requirements in private business. As concrete evidence of the need for a census Dr. Rice cited a number of state and local censuses which were being suggested because no recent Federal census was available to meet these needs. Dr. Rice discussed in very tentative fashion a number of items which might be included on a census schedule. He pointed out the development of new concepts of unemployment statistics, particularly in connection with the measurement of degree of unemployment and the distinction of various classes of unemployed workers.

The statistical work of the National Recovery Administration was discussed by Dr. Theodore J. Kreps, Chief of the Statistics Section of its Division of Research and Planning. He pointed out that the statistics section was less than a year old and that there was considerable diversity of opinion as to its policies and functions. He stated that 456 of the 729 codes provide for the collection of statistics by code authorities and that many of the other codes provide other arrangements for the collection of statistics. Dr. Kreps described the development of relationships between the statistics section and the code authorities by which the results of these statistical activities were being improved in quality and accuracy and assembled for use in Washington. He also pointed out that considerable progress could be reported in limiting duplication and restricting the amount of statistics collected. A very

advantageous step had been taken in disassociating statistics from code compliance.

Dr. William E. Mosher, Federal Power Commission, discussed the Electric Rate Survey of which he is Director. After briefly describing the work of the National Power Survey, which is another part of the Commission's activities, Dr. Mosher pointed out some of the problems that presented themselves in connection with the work of the Electric Rate Survey. Due to the diversity and complexity of the vast number of rate schedules which were filed with the Commission, specifications had to be set up for typical domestic usages of electricity and applied to the rate schedules of the utilities, both privately and publicly owned. Some difficulties were encountered in the application of the rate schedules to the specifications, due primarily to the complexity of the schedules, but in general the results obtained were satisfactory. Several extreme examples of complex and involved schedules were cited, and the methods employed in securing basic data by direct contact in the field with managers and other responsible officials of power plants were described.

The Society was privileged to have as its guest Dr. R. H. Coats, Dominion Statistician of Canada. Dr. Coats announced that a conference of statisticians of the British Commonwealth would meet in Ottawa in September. He also described the establishment of an Economic Council for the Dominion of Canada of which the Dominion Bureau of Statistics is the working arm and the Director of the Bureau, Executive Officer. He cited this development as recognition of the importance of economic research.

Dr. Mordecai Ezekiel was elected President and Dr. Theodore J. Kreps, Vice-President of the Society.

STATISTICAL NEWS AND NOTES

Securities and Exchange Commission.—The statistical activities of the Securities and Exchange Commission during the first year of its existence have centered, so far as statistics regularly compiled and released to the public are concerned, around the registrations of new securities under the Securities Act of 1933, and the volume and value of trading in securities on national securities exchanges. At the present time the Commission is releasing regularly the following series:

1. Securities filed and registered with the Commission. While only summary totals are released for filings, the statistics of effective issues (released around the 15th of the month following the registration) are of a rather detailed nature. They show the types of securities registered, estimated gross proceeds, amounts not presently offered for sale, costs of selling and distribution, channels of distribution of securities, net proceeds and contemplated uses of funds raised by the issuers (segregating expenditures for new plant and equipment, purchase of equipment, purchase of

investments, repayment of indebtedness, and working capital). Only grand totals for all securities declared effective are published, but records which are the most detailed statistics of security issues available in the United States at the present are kept for the individual industries. But it should be noted—

a. that these do not include issues of the United States Treasury and the Government agencies, of states and municipalities, of railroads, and of charitable and educational institutions, nor intrastate and various types of private placings, all of which are exempt from registration, and

b. that they are statistics of permits to sell securities rather than of securities actually sold. The Commission has no authoritative information as to this last item.

In addition to these statistics, itemized lists are released of issues filed (weekly) and issues effective (monthly) containing a description of the securities to be issued and their amounts and proposed offering prices.

2. Volume and value of trading in stocks and bonds on each and all registered exchanges. This series is released about the 25th of the following month. The number of shares and par value of bonds traded, as well as their trading market value, is given. The figures include in almost all cases transactions which are not reported in the quotation sheets or on the ticker; for instance, odd-lot transactions and stopped-stock on the New York Stock Exchange.

In addition to these statistics which are made available to the public, the Commission is compiling totals for sales and purchases of securities reported under section 16 of the Securities Exchange Act of 1934 (transactions by principal stockholders, directors, and officers), an itemized record of which—without any statistical summary—is released to the press around the 10th and the last of each month.

Various special studies bearing upon some technical aspects of underwriting, trading, and security exchange practices, made by the Office of the Technical Adviser, contain statistical material but none has been made public hitherto.

FEDERAL DEPOSIT INSURANCE CORPORATION.—Clark Warburton, Donald S. Thompson and Florence S. Helm have completed a critical and extensive examination of the available information on losses to depositors. They have developed estimates for losses to depositors during the last seventy years and have made separate estimates of losses for accounts which would have been eligible for insurance had the present plan been in operation. Their detailed reports, "Losses to Depositors in Suspended Commercial Banks, 1865 to 1934," and "Losses to Depositors in Mutual Savings Banks, 1865–1934," are included in the annual report of the Federal Deposit Insurance Corporation for the year ending December 31, 1934.

BUREAU OF INTERNAL REVENUE.—The "Statistics of Income for 1933" complete report, compiled from income tax returns filed by individuals and corporations during the calendar year 1934, and including statistics from Estate Tax returns and Gift Tax returns, likewise filed during 1934, should be released before the end of the year.

The work of classifying the data in the income tax returns for 1934, filed in 1935, is also well under way. These data will be published in preliminary form and in complete form, entitled "Statistics of Income for 1934", which will be the latest volume in a series covering nineteen consecutive years for which an analysis has been presented of the individual and corporation income tax returns.

Strict comparability of many of the important series contained in these volumes has not been possible throughout the nineteen year period, because of statutory changes affecting the filing of returns and methods of determining taxable income. Even with respect to the returns for 1934, which are now being tabulated, several new factors have been introduced for the first time, chief among which are the provisions relating to consolidated corporation income tax returns and method of reporting capital gains and losses by individuals and corporations.

The 1934 Act withdraws the privilege of filing consolidated corporation returns (except in the case of railroads). As to capital gains and losses, the method provided by that Act is, in general, to exclude from net income a certain proportion of the gains and losses realized from the sale of capital assets computed on the basis of the number of years held.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE.—Strenuous efforts have been made to push to completion studies mentioned in the last issue of the JOURNAL. The "World Economic Review", covering data for 1934, will be available by the time you read this note. The foreign section will be presented as it was in 1933. A few changes have been made in the presentation of the material in the American section, but this section will be comparable to that of 1933. Copy for the "Foreign Commerce Yearbook" is on its way to the printer.

The "Balance of International Payments" has been published. The Finance Division has undertaken several studies which will contribute to the interpretation of the "invisible" items in future issues of this annual publication. Special attention is being given to the problem of international insurance transactions and to a census and analysis of the foreign ownership of American shares and bonds.

"Foreign Trade of the United States", calendar year, 1934, an annual publication of the Bureau of Foreign and Domestic Commerce, will be available about the end of September. "Foreign Commerce and Navigation of the United States", calendar year, 1934, will appear in two volumes this year. The first volume will probably be released in July.

All the work on the "National Income" study has been completed and copy will be available from the printer shortly. Estimates for 1933 and 1934 will

be given, together with a revision of the data for 1929–1932. Early in June the Division of Economic Research published "A comparative tabulation of more than 100 current business series" which proved to be of special service in evaluating the progress of recovery.

The first attempt to correlate data on incomes and consumption derived from information, on both incomes and goods, reported by the same families has been published in "Consumer Use of Selected Goods and Services, By Income Glasses". Data for this study, covering a sample of families in Austin, Texas, were drawn from the Real Property Inventory and the Financial Survey of Urban Housing. Similar studies for Fargo, North Dakota and Portland, Maine, have been completed. Reports on other cities are in preparation.

The "Retail Credit Survey, 1934," which has become an annual publication of the Marketing Research and Service Division, was released in June. An analysis of the proportions of cash, open-credit, and installment sales was made for 1934 on the basis of some 1,144 reporting retail stores in 12 kinds of business.

"Code-Sponsoring Trade Associations" was published in July. This publication lists every industry which had a code under the National Recovery Administration, the Agricultural Adjustment Administration, or the Federal Alcohol Control Administration and gives statistical references. It is the only list that statisticians have providing this type of information.

Special tabulations and interpretations of data collected by the Bureau of the Census are being made in order to show the location of small and large retail stores in rural and urban places. Preliminary summaries by states for about half of the states have already appeared in issues of *Domestic Commerce*. The complete report will not be available for some months.

Statisticians interested in marketing problems will find the "Check-Sheet—Introduction of New Industrial Products", released in July, of value in suggesting important data which is necessary to the introduction and successful establishment of new industrial products.

Other studies by this Division which have just been completed and which will be available shortly are "Store Modernization Needs"—a statistical survey made with the cooperation of the Federal Housing Administration: and "Retail Parcel Delivery Study"—a directory and analysis of this growing business.

The Foodstuffs Division has reported on "Mayonnaise, Salad Dressing and Related Products, 1934" and on "Confectionery Distribution in the United States, 1933–1934". Some of the data in the confectionery study was worked out in cooperation with the Tariff Commission.

Final reports on the Financial Survey of Urban Housing have been completed and plans for printing, which include separate reports for each of the sixty-one cities, are being made.

A bibliography of "The Negro in Business—1935" was published in July. The "Note" in the last JOURNAL about "a revised list of Short Wave Receiving Stations" was an error. The publication undoubtedly referred to is the

revision of the August, 1934, edition of "World Short-Wave Radiophone Transmitters".

NATIONAL RECOVERY ADMINISTRATION.—The decision of the Supreme Court invalidating the codes has necessarily curtailed considerably the statistical activities of the National Recovery Administration. Code authorities no longer exist. Code provisions concerning the collection of statistical information are no longer enforceable. Fortunately, however, in most industries trade associations have been glad to assume the responsibility of carrying on, so that a large part, if not all, of the worthwhile statistical programs will be maintained relatively unabridged. Precisely how much will be ultimately salvaged cannot now be estimated.

During the months of May and June the National Recovery Administration embarked on a study of the history of the fifty largest industries under the codes. A large crew of investigators has been operating in the field gathering all the available data that had accumulated in the files of the code authorities and interviewing trade association executives and business men. These gleanings from the field are now being collated with the materials in the files of deputy administrators and other officials of the National Recovery Administration, with the statistics presented in the publications of other Governmental departments and with the results obtained through academic or other research.

In the reorganized National Recovery Administration the Division of Review under the direction of Mr. Leon C. Marshall has been given, among other responsibilities, the mandate to extend and complete these industrial studies. In addition, the Division of Business Cooperation, under the direction of Mr. Prentiss Coonley, has been assigned the task of observing closely the effects of the abandonment of the codes upon hours, wages, employment, prices and competitive practices.

The Statistics Section has been maintained intact in the Division of Review, Mr. William J. Maguire, formerly Assistant Chief, now being Acting Chief. The former Chief, Dr. Theodore J. Kreps, resigned to accept a position on the staff of the Central Statistical Board as Chairman of the Coordinating Committee of Central Statistical Board and the Works Progress Administration.

FEDERAL TRADE COMMISSION.—The Cabinet Textile Committee, composed of the Secretaries of State, Labor, Agriculture, and Commerce, has requested the Federal Trade Commission to prepare an extensive series of tabulations for the cotton textile industry covering a breakdown of companies according to the character of product manufactured and showing distributions of various expense and profit data in these various lines of business according to the size of the investment, rate of profit on sales, and rate of return on investment. The funds are not yet available for the making of these analyses but it is possible that the money necessary for this work will be made available through the efforts of the Cabinet Textile Committee or otherwise.

There is also the possibility that the textile reports may be continued for two or three additional six-months periods in 1935 and 1936. The tabulation of the results for textile establishments for the last six months of 1934 are well along toward completion and it is expected that the reports covering four six-months periods, two in 1933 and two in 1934 will begin to be issued shortly. The reports covering these four six-months periods will represent a far larger number of companies than those for which results were made available by reports covering the two six-months of 1933, the first six months of 1934, and the July–August, 1934, period.

On June 20th the Commission published as Part VI of its report on Textiles, in mimeographed form, a series of twenty-four tables showing distributions of certain principal items of investment, income, and expense according to the size of companies, according the rate of return earned on the textile investment, and according to the rate of profits on sales. On account of the large expense involved it seems probable that these tables will not be printed. Only a limited number of copies of them are available.

The Commission on May 10th sent to the Congress its report on the "Sale and Distribution of Milk Products in the Philadelphia and Connecticut Milksheds." This report contains some interesting figures on the sales and operating expenses of milk distributors in these two sheds. Sales of fluid milk and cream on wholesale and retail routes are shown separately from other sales of fluid milk. Sales of ice cream and mix and of other manufactured and purchased products by such distributors are also shown separately. There are possibilities that the milk inquiry may be continued by Congress in other sheds than the two above mentioned.

The report contains an interesting statistical study of the amounts of underpayments by dealers to farmers showing, for example, such things as the amount of milk sold in Class 1, the amount of milk purchased at the Class 1 price, and the amount of Class 1 sales in excess of Class 1 purchases and other similar data.

Bureau of Agricultural Economics.—There has been prepared in the Division of Statistical and Historical Research a survey of the food supplies for 1933, 1934, 1935, and the 1929–1933 average. To give an index of total food supplies for these periods, the total supplies of food have been converted into calories. Domestic disappearance is also shown in calories.

As an outgrowth of the consumer's survey portion of the economic analysis of the live poultry industry in New York City, mentioned in the June issue, a new project has been started which uses the questionnaire survey method to determine consumption and marketing data for all the principal agricultural food products. A questionnaire is devised for a particular group of products, as meats, and is filled out by enumerators interviewing housewives during a two or three week period. At the end of this time a new questionnaire covering a different food group is substituted. It is planned that each food group will be covered once every three months. The sampling method has been arranged to allow successive daily samples of

about 500 records to be drawn over a considerable period, each sample being independent of the others and each believed to be representative of New York City. The New York City Department of Public Markets, Weights and Measures is cooperating in this work and the Emergency Relief Bureau there is supplying the personnel.

The Division of Statistical and Historical Research has made estimates of the annual production of manufactured dairy products, from 1869 to date. This work is part of the general project of revising estimates of agricultural production. The per capita production of manufactured dairy products increased from 1869 to about 1896, but since then has shown relatively little change.

"The Margin Between Farm Prices and Retail Prices of Ten Foods" is a recent report prepared in the Division of Marketing Research. It summarizes since 1910 the total price spreads often of the most important farm products without including details as to what constitutes these spreads.

"An Economic Study of Wholesale Prices at Cincinnati, 1844–1914", (a doctor's dissertation, Cornell University) by Henry Ellis White, contains comprehensive data on wholesale prices. Part 1 deals with index numbers on wholesale prices at Cincinnati and contains numerous charts and considerable historical information. Part 2 deals with supply-price relationships. The Appendix contains over one hundred commodity price series and a number of other statistical series.

From January to May, 1934, the Bureau of Agricultural Economics, working with Federal Emergency Relief Administration funds, and assisted by the Agricultural Experiment Stations in the 48 States, collected records of tax delinquency, tax sales and land transfers in 2,350 of the 3,071 counties in the country. The delinquency records covered the five levies 1928 to 1932, and transfer records were carried back through varying periods. Tax delinquency data were summarized for 1,500 counties in the field showing a three- to four-fold increase for the period. Then between June 1934 and February 1935 the records were analyzed in more detail for about 600 counties.

The work has served to measure and classify delinquency by area, type, duration, disposition, etc. Equally as important, it has stimulated local thinking on the rural tax situation, and has led to further work on the problem in probably a majority of the States. The problem is far more complicated than commonly assumed, and close consideration of detailed information is helping to develop a better understanding of this complex and important problem.

Rural taxation, assessment and collection problems do not stand forth in their true light until inability to pay is understood. The C.W.A. offered the unique opportunity of obtaining the necessary information, the project being one of the two largest Federal statistical projects authorized by that organization. Twenty-two State summaries have been issued by the Bureau, and others will follow as available. Transfer data are being separately tabulated for publication in the very near future.

THE CANADIAN CENSUS.—The Administrative Report of the Dominion Statistician on the Seventh Census of Canada 1931, recently issued, contains much information of interest and importance to the statistical world. Especially to be noted, from the historical point of view, are the facsimile reproductions of original returns of the names, ages and occupations of the people of Canada as compiled at the first and second censuses of 1666 and 1667. The sections dealing with the methods adopted in the Census of Institutions and the Census of Distribution are especially worthy of attention in view of the novelty of such investigations. Statisticians will also be interested in the invention in the Bureau of improved labour-saving census machinery, especially the new sorter-tabulator, described at pages 35 and 36. The census reports are planned to include eleven volumes of tables, two volumes containing twelve important census monographs described in the Report, and a fourteenth volume consisting of a statistical atlas of the Dominion. The relevant sections of the Statistics Act are included in the appendices, together with the questions asked on the various schedules.

Volume III of the Seventh Census of Canada of 1931, recently published by the Dominion Bureau of Statistics, is concerned with the ages of the people, and cross-classifies the population of the various ages by sex, conjugal condition, racial origin, religion, birthplace, language, literacy, school attendance, year of immigration, naturalization, etc. This information is provided for the Dominion, for provinces and for cities of 30,000 population and over. It comprises a volume of tables extending to more than 1,000 pages. Analyses and interpretations of the data included will appear in various monographs now in process of preparation.

THE CANADIAN PRICE SPREADS COMMISSION.—A Select Special Committee of eleven members of the Canadian House of Commons was appointed in February 1934, as a result of a resolution of that House, to enquire into the effects of mass buying by department and chain store organizations on the trade of that country, the labour conditions prevailing in industries supplying the requirements of such department and chain store organizations, the relations between the flour milling industry and the bakers of the country and the methods prevailing in the marketing of live stock and animal products for domestic consumption and export. Since the Committee was unable to complete its work within the Session of Parliament, it was reconstituted as a Royal Commission and took evidence during the recess. Its report was presented to the House on April 12, 1935, and, together with the evidence, contains an enormous amount of information never before made available regarding business practices and financing in Canada. The contents of the Report may perhaps be indicated by the titles of its chapters as follows: Introduction; Economic Background; Concentration and the Corporate System of Business; Industry; Labour and Wages; The Primary Producer; Distribution; The Consumer; The Problem of State Control. The text of the Report extends to some 300 pages and is followed by 129 tables, which, to-

gether with the accompanying text, deal with various phases of business in Canada.

Economists and statisticians, however, especially if they are teachers in search of case material, will be even more thoroughly interested in the 9,000 pages of evidence now printed and made available to the public, constituting a wealth of information on Canadian business conditions, comparable in certain respects to the reports of the Industrial Commission of 1899 to 1901 in the United States. Particularly notable is the wealth of hitherto unpublished detail on the business methods and earnings of the great departmental stores and chain store organizations and their effects upon producer and consumer. Equally important is the material made available regarding the relations of monopolistic or quasi-monopolistic industrial organizations with those who provide their raw materials. Economists and statisticians in the United States will be interested in many parallels between Canadian and United States conditions and in the respective powers of the federal governments in the two countries.

BUREAU OF LABOR STATISTICS, U. S. DEPARTMENT OF LABOR.—An analysis is being made of cases of attachment of wages for debts. The data cover wage executions among employees of 176 firms in 31 cities of 21 states. This analysis will show some of the results of inflated consumer credit.

As an indication of the employment furnished indirectly by public-works and work-relief projects, a study has just been completed showing the indirect labor requirements in the construction of houses by the Tennessee Valley Authority.

Continuing the annual surveys of operations under the state old-age pension acts, which have been carried on by the Bureau since 1928, data have been compiled showing the experience in 1933. As that year will probably prove to have been the last under the old order, i. e., the last under the unaided state systems, a rather more extensive analysis than usual has been made.

Other studies under way include an analysis of personnel policies in cotton mills, data for which were collected in the course of a recent wage study made in this industry by the Bureau, and a survey of wages in the water transportation industry.

UNITED STATES EMPLOYMENT SERVICE.—One of the most comprehensive sources of detailed information concerning the unemployed population of the country is furnished by the statistics gathered by the United States Employment Service. This organization has offices in every sizeable community in the country and during the past two years has registered and classified over 16,750,000 job-seekers and has made some 9,700,000 placements in gainful employment.

Succeeding a system of simple weekly reports of operating totals, a comprehensive statistical program was instituted in July, 1934, which in addition to operating records, provides detailed information of every person registered

or placed. The program has been designed with a dual purpose, first, to provide accurate records of the work of Employment Service offices to serve as an administrative guide, and, secondly, to provide a comprehensive source of information concerning the characteristics of the unemployed group throughout the country and an indication of some of the more important unemployment trends.

The daily reports of transactions indicate for each applicant or person placed his occupational classification and the type of industry in which he was formerly employed or is being placed, and such personal details as age, color, sex, length of unemployment (in the case of applicants), veteran status, relief status and additional pertinent information as specially desired from time to time. A report of starting wages and hours is also made in the case of all placements.

By means of mechanical tabulation of these standard reports, monthly, nationwide summaries of the material are prepared regularly. These summaries provide valuable source material regarding such vexing problems as the extent of unemployment among youth, the question of the much discussed "forty-year deadline" of employment, displacement of men by women, average length of unemployment in various occupations, employment trends between industries and similar problems of general interest. The report of beginning wages and hours, while only a sample, offers one of the few sources of current, directly comparable information on prevailing wage rates and hours of labor.

The Employment Service is also carrying on an extensive program of occupational research designed to provide improved methods of placement procedure and vocational guidance. Through a careful analysis of jobs and of workers in various occupations, it is hoped to determine the characteristics which are commonly found in successful workers in various occupations and to establish standard job descriptions. Ultimately, it is hoped that by determining the basic characterstics common to apparently dissimilar jobs, it will be possible to transfer workers from occupations of limited employment opportunities to more promising fields, without loss of their skills and training. While of first use to the Employment Service, this program will provide information of basic importance to all fields of personnel work and vocational guidance.

Employment Service statistics, while not directly a report of total unemployment, provide the largest single detailed sample regularly available. Regular weekly summaries of the number of men and women registered for jobs in each county are available with a lag of but five days from the date of reporting. It now is planned to secure at quarterly intervals a detailed analysis of this supply of workers, giving an occupational inventory of all available registered workers. With the classifications by sex, age, color, etc. reported for these workers, this labor inventory would provide a continuing representative sample census of unemployment.

CHILDREN'S BUREAU, U. S. DEPARTMENT OF LABOR.—A study of conditions

in families under the care of agencies doing public health nursing was made under the direction of the Children's Bureau during the week of November 19, 1934, with a view to obtaining a picture of the situation in a large group of families throughout the country, particularly with respect to food consumed by children of different ages; the extent of overcrowding in the households; special physical needs of the children known to the mothers and the extent to which these needs were being met; and the difference in respect to these factors in relief and non-relief families, both colored and white.

Assistance was asked of public-health nurses under public-health departments and private nursing associations in 57 cities of different sizes and geographical location. For two days during the week of the study, the nurse was asked to fill out a schedule for every family visited. The information obtained covered 10,255 families with 4,084 children under 1 year of age, 10,269 children between 1 and 6 years of age, and 13,847 children of 6 to 15 years of age inclusive.

Information on diets and physical defects known to the mother to need attention was collected for a total of 26,175 children. Questions were asked as to the amount of milk used in the home during the previous week, and the amount taken by children and pregnant and nursing mothers the previous day. Inquiry was also made as to the inclusion of butter, fruit, and vegetables in the diet of the children the previous day. The schedule also showed the total number of persons living and eating in the home, and the number lodging but not eating with the families.

WOMEN'S BUREAU, U. S. DEPARTMENT OF LABOR.—The third report of a series on industrial injuries to women was released in June of this year. It contains data from 16 States for the years 1930 or 1931 or both. South Dakota and North Carolina started, and Minnesota and New Jersey resumed, reporting by sex in the period included. The other States reporting on industrial injuries by sex are Colorado, Idaho, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, New York, Pennsylvania, Rhode Island, and Wisconsin.

A direct relationship between unemployment and industrial injuries during 1930 and 1931 is shown by this report. The number of injuries decreased in this period, the decline being especially marked in 1931. In general, women's injuries decreased less than men's. The report also presents data on nature, degree, and cause of the injury; as well as on earnings, age, marital status and dependents of the injured; and on industries where the injuries occurred.

A second current Women's Bureau report is a study of various phases of women's employment in the sewing trades of Connecticut. A preliminary report of findings as to factory earnings and hours was published shortly after the survey was made in the fall of 1931. The other data, owing to pressure of more urgent work, were not prepared for publication until recently.

A third recent Women's Bureau publication contains evidence that women out of work and seeking office employment even in the earlier years of the depression were average and representative workers. Cross sections of two groups of women clerical workers are presented in this study, the first giving

a picture of such workers with jobs, the other of job applicants, most of whom were unemployed. The data on the first group—5,000 employed office workers—were secured through questionnaires filled in by women at Y. W. C. A. clubs and camps in 39 States and the District of Columbia in 1930–31. The data on not far from 5,000 women seeking office jobs were obtained from employment services, both free and fee-charging, in six cities—Atlanta, Des Moines, Chicago, New York, Philadelphia, and St. Louis in 1931–32. Comparatively little difference was found in the education, in the age, or in the earnings on the current job or last job held, between the group of all women employed and the group of applicants.

OFFICE OF EDUCATION.—On June 19 to 21 representatives of State Departments of Education met in Washington at the invitation of the Office of Education to consider ways and means to improve the reporting of educational statistics by State Departments of Education. Two committees reported, one on "a minimum list of statistical items to be collected by State Departments and reported to the Office of Education," and the other on "accepted definitions of statistical terms in order to secure uniformity." The final report will soon be issued by the Office of Education.

Two chapters of the *Biennial Survey of Education* for 1932–34 have recently been sent to press. They are "Statistics of private elementary and secondary schools, 1932–33" and "A review of educational legislation for 1933–34" which reports new developments in financing schools.

An advance study of 41 State school systems will soon be issued in mimeographed form. It will cover items of enrollment, number of teachers, general expense, etc. Another study soon to be issued is "Statistics of the Education of Negroes," covering the elementary through college levels for 1931–32.

All these studies may be secured by writing directly to the Office of Education.

FEDERAL EMERGENCY RELIEF ADMINISTRATION AND WORKS PROGRESS ADMINISTRATION.—*Works Program Statistics.* The Federal Works Progress Administration is charged with the responsibility of making periodic reports of employment and progress on all projects under the Works Program operating with funds appropriated under the Emergency Relief Appropriation Act of 1935.

Statistical and reporting problems under the Works Program differ materially from those encountered under the Civil Works and emergency relief programs. New problems arise because of the division of administrative responsibility between different agencies. While certain agencies will sponsor projects, others will supervise project operation under varying conditions regarding wage rates, hours of labor, and payroll requirements, and, furthermore, important functions serving as the basis for reports and statistics, such as purchasing, accounting, and disbursing, will be under the administrative control of divisions of the Treasury Department.

Periodic reports on the progress of the program will include such items as

employment, payrolls, man-hours, extent of completion of projects, physical accomplishment, amount of materials used, total expenditures and commitments, amounts of State and local contributions, and fluctuations in the available labor supply.

Detailed reporting forms and instructions are in preparation (July 11, 1935) and will be completed as determination is made of the operating and accounting procedures upon which they will be based. Insofar as possible statistical information will be assembled in 11 Area Statistical Offices, directed by the Works Progress Administration from Washington, and used as the basis of reports, summaries, and analyses. The data for reports will to a large extent be drawn more or less automatically from copies of operating and administrative documents, such as payrolls and purchase orders, rather than from reports of the type extensively used under the emergency relief program, made by local administrations.

Revision of Relief Reports. Certain modifications in the monthly relief reports which are submitted by the State Emergency Relief Administration to the Federal Emergency Relief Administration became effective July 1, 1935. A new report (F.E.R.A. Form 192) was instituted for the purpose of obtaining data concerning the number of resident cases which during a given month receive both relief and payments for work performed under the new Works Program. This report was necessitated by the fact that cases are being assigned to the new Works Program gradually during each month, rather than being transferred in a group on a given date. Minor changes are being made in a number of report forms and several forms are being discontinued.

Occupational Inventory of the Relief Population. The transition from relief to the Works Program required a comprehensive occupational inventory of the entire employable relief population. To this end, the tabulation of certain specified personal and occupational information from the occupational classification card (Form 144) was undertaken in May 1935. The inventory includes all persons receiving relief in March 1935 who were working or seeking work, showing for all such persons the usual occupation by race, sex and "work priority." A preliminary tabulation, covering a twenty per cent sample of relief cases, presenting an occupational distribution for each State by urban and rural areas, and showing separately all cities with a population of 100,000 or more, was completed in July and summary tables are available. This tabulation was followed by a tabulation covering the complete relief registration, by counties. In addition, it is planned to maintain a perpetual labor inventory of persons eligible for employment on the Works Program.

Retail Prices and the Cost of Living. Field work required for the pricing of commodities and services to be used in estimating the cost of living of industrial, service, and other manual workers in 59 cities has been completed; and tabulation of the data is in process (July 10, 1935). About 70,000 schedules have been collected and approximately a million quotations will enter into the analysis. This analysis will show comparative costs of

an identical bill of goods and services in 59 cities, with such modifications as are necessitated by conditions of climate and local consumption habits, but without variation in the standard of living. The results should give a clear picture of the relative cost of living of low-income families at a basic maintenance standard and an emergency standard.

Sources of State Relief Funds. It is the purpose of this study to discover the actual sources from which States obtained the funds expended by them for emergency unemployment relief purposes during the fiscal year 1934–35. It reveals the proportion of the $200,000,000 contributed by State governments for relief purposes in 1934–35, which were obtained from general revenues, bonds, gasoline taxes, motor vehicle registration fees, sales taxes, liquor revenues, income taxes, and various miscellaneous sources. The information is obtained from the forty-eight State relief administrators with the aid of questionnaires prepared individually for each State on the basis of the relief legislation enacted by that State.

A tabular digest of State legislation for the financing of unemployment relief in the various States enacted between the beginning of 1931 and the middle of 1935 has already been completed. (Cf. F.E.R.A. *Report,* May, 1935.) A previous study published in the F.E.R.A. *Report* for September 1934 presented the results of an analysis of the revenue sources of State funds expended for unemployment relief during the period January 1, 1931 to June 30, 1934. That study revealed that prior to the middle of 1934 the bulk of State unemployment relief financing was emergency in character, with increasing proportions of State relief funds being derived through the issuance of bonds. Preliminary results indicate that during the fiscal year just ended, the trend has been away from borrowing as a means of raising State relief funds and has been increasingly in the direction of taxation. The results of the study will be published in the *Monthly Report* of the F.E.R.A. A similar study covering the relief expenditures of all cities with a population of over 100,000 during the period since 1931 is now under way.

State and Local Liquor Revenues. In this special study, the revenue productivity of liquor licenses, liquor taxes, and State-owned liquor stores under the different methods of regulation employed in the various States since the repeal of prohibition will be analyzed. Its ultimate purpose is to estimate the probable yield of a uniform liquor system. As such, it comprises an integral part of a broader study of the abilities of the various States to raise revenues for emergency relief purposes. As a preliminary step to the analysis of State and local liquor revenues, a detailed tabulation has been made of the legal provisions for liquor (including beer) licenses and tax rates, and the disposition of liquor revenues in the various States. The study is conducted in cooperation with the American Legislators Association, and clearance has been established with other agencies interested in the subject matter in order to avoid duplication of effort.

COORDINATING COMMITTEE FOR STATISTICAL PROJECTS.—A coordinating committee of the Central Statistical Board and the Works Progress Administra-

tion has been established for the purpose of reviewing all statistical, survey, and research projects to be conducted under the new Works Program. The functions of this committee will be similar to those performed under a corresponding relationship between the Central Statistical Board and the Civil Works Administration under the Civil Works Program. The chief functions of this committee are to assure that projects are of a high caliber, that they are adequately supervised, that the results are worthwhile, and that duplication is avoided. Before statistical projects are initiated under the Works Program they must be approved by this committee and the committee retains the right to stop projects at any time from the date of initiation to the date of completion. The committee is organized into two sections, a Technical Appraisal Section and a Field Supervision Section.

DEPARTMENT OF JUSTICE.—*Criminal and Civil Court Statistics.* Beginning January 1, 1935, individual card reports have been received for defendants entered for prosecution on the dockets of the Federal District Courts and also for cases disposed of by the courts. A statistical summary is being made of these Criminal Docket reports for the six months' period ending June 30, 1935, and will be published in the Annual Report of the Attorney General for the fiscal year 1935. A principal feature of this summary will be a study of types of disposition in relation to offense and to judicial district. These statistics will also provide, for the first time, data for the entire country concerning the distribution of convicted Federal offenders according to types of penalty or treatment. In compiling these statistics, the Department is using a new classification of Federal offenses, which corresponds with the standard offense classification used by the Bureau of the Census, in its statistics of prisoners and its state judicial statistics, and by the Bureau of Investigation of the Department of Justice in its police statistics.

The Department is also analyzing individual reports of all civil cases filed on the dockets of the Federal Courts, and those terminated during the six months ending June 30, 1935. These new civil court statistics show in detail the nature of the suit, the time required for cases to pass through the courts, and their outcome. The collection and analysis of this information, as well as of the criminal court statistics, are largely based upon plans developed by Dean Charles E. Clark of the Yale Law School and his associates, who conducted an intensive study of the business of the Federal Courts in 13 representative Judicial Districts. This study was inaugurated and largely financed by the National Commission for Law Observance and Enforcement (the Wickersham Commission), while the report has been published by the American Law Institute. The Department is using its new court statistics to develop more effective administrative control of the operation of the Federal Courts.

Parole Survey. As an outgrowth of proposals made by the American Parole Association, plans have been made for an official country-wide study of cases under parole supervision, with particular reference to their success or failure on parole and the personal factors associated with success and

failure. This study, if undertaken, will be financed under the new work relief appropriation, and will be based on official records of a large number of state prisons and reformatories, in states which undertake to cooperate in the project. As a basis for this proposed country-wide project, the Federal Emergency Relief Administration has financed a preliminary analysis of Federal parolees, which will be of very great value for evaluating the effectiveness of Federal parole supervision.

STANDARDIZATION OF BANK REPORTS.—A conference on the standardization of call reports and earnings and dividend reports was held on May 22 and 23, 1935. Attending this conference were representatives of the American Bankers' Association, the Comptroller of the Currency, the Federal Deposit Insurance Corporation, the Federal Reserve Board, the National Association of Bank Auditors and Comptrollers, the Reconstruction Finance Corporation, the Reserve City Bankers Association, the National Association of Supervisors of State Banks and the United States Treasury. As a result of the conference a standing committee to develop new forms was appointed with Mr. H. B. Wells, Bank Supervisor and Supervisor of Research and Statistics, Department of Financial Institutions for the State of Indiana, as chairman. The conference passed a series of resolutions recommending that call reports for supervisory purposes be made as few and as simple as possible under existing laws and that the supervisory aspects of the call be separated from the economic and statistical aspects. The conference also recommended to the national associations which it represented that aggressive educational campaigns be conducted for greater standardization in accounts and accounting terms. The August number of *Banking* carries a discussion of the conference by Mortimer J. Fox, Jr., Chief of the Division of Research and Statistics, Federal Deposit Insurance Corporation, and secretary of the standing committee.

NATIONAL BUREAU OF ECONOMIC RESEARCH.—On July 1, the National Bureau published Bulletin 57: "The National Bureau's Measures of Cyclical Behavior," by Wesley C. Mitchell and Arthur F. Burns. This 20-page description of the National Bureau's methods for the analysis of business cycles is issued as one number of the current series of Bulletins. Extra copies are available for classroom use. It presents a specimen analysis of a series so that anyone may follow each step for himself. The method is illustrated by charts of over thirty important indicators of business conditions, ranging from general indexes to the production of leading staples, commodity prices, foreign trade, stock prices, and interest rates.

It is expected that Dr. Mitchell's second volume on business cycles, *Analysis of Cyclical Behavior,* will be published in 1936. The necessary statistical computations should be completed by the end of this year. Meanwhile the three first chapters of the forthcoming book are in preliminary form and plans have been made to make mimeographed copies available for those wishing to use the material for reference or for classroom work.

The National Bureau also announces the publication of *Public Works in Prosperity and Depression, and Their Utilization as an Agency for Economic Stabilization,* by Dr. Arthur D. Gayer. The report was prepared for the National Planning Board of the Federal Emergency Administration of Public Works and contains a short introduction by the Chairman, Frederic A. Delano. Dr. Gayer supplements the extensive study of the subject made while a Research Associate of the National Bureau with a discussion and analysis of the recent public works program.

A COMMITTEE on the Interpretation and Presentation of Data of the American Society for Testing Materials has been active in developing and promoting the use of statistical methods in connection with the presentation of data on the materials of engineering and the standardization of specifications and the methods of testing. In 1933 the Committee published a manual on the presentation of data. It plans to publish additions to the manual from time to time and to extend its scope to cover problems of interpretation. The Society is finding the use of statistical methods of very great assistance in dealing with the measurement of physical constants and frequency distributions, the discovery of functional and statistical relationship between two or more variables, and the discovery of causes of observed phenomena. The chairman of the Committee is Anson Hayes, Director, Research Laboratories, The American Rolling Mill Company, Middletown, Ohio.

CANADIAN POLITICAL SCIENCE ASSOCIATION.—The seventh annual meeting of the Canadian Political Science Association was held at Queen's University, Kingston, Ontario, on May 28th to May 30th, 1935. The papers were chiefly concerned with the vexed question of the division of jurisdiction between federal and provincial authorities in various fields, including discussions of the philosophy of federalism, sectionalism in Canadian politics, the effects of the tariff upon the different sections of the country, the constitutionality of such legislation as the Natural Products Marketing Act and the proposed measures of social insurance, together with discussions of the wheat problem, the newsprint situation, etc. The papers and a summary of the discussions are to appear in the August number of the *Canadian Journal of Economics and Political Science,* a new quarterly journal which was substituted for the former annual volume of proceedings at the beginning of 1935.

MANCHESTER STATISTICAL SOCIETY.—The Manchester Statistical Society has published a booklet containing brief summaries of the very interesting papers read before its Group for the Study of Statistical Methods during 1934 and the first half of 1935. The following papers are included: Colin G. Clark, "The Statistical Measurement of Business Activity"; L. H. C. Tippett, "Methods of Analysing Time-Series"; C. T. Saunders, "Seasonal Variations in Employment in the United Kingdom"; H. Campion, "The Measurement of Price Changes"; N. W. Ross, "An Attempt at Forecasting the Population of Manchester and Lancashire"; D. Caradog Jones, "The Co-ordination of

the Records of Births, Marriage and Deaths"; D. H. Peacock, "Banking Statistics and Their Interpretation"; Dr. K. G. Fenelon, "Transport Statistics"; R. Robson, "The International Comparison of Industrial Production"; Dr. Adolf Löwe, "Some Theoretical Considerations of the Meaning of 'Trend'"; D. N. Chester, "The Optimum Size of a Local Authority" and George Darling, "Some Aspects of Retail Distribution."

THE PSYCHOMETRIC SOCIETY.—The Psychometric Society will be formally organized at a meeting in Ann Arbor, Michigan, in September, 1935, by a group of psychologists interested in the mathematical and statistical approach to psychological problems. The primary purpose of the organization will be to promote the development of quantitative rationale in the solution of psychological problems. This necessarily means the formulation of hypotheses in mathematical form, their development into a consistent quantitative psychological theory, and quantitative tests of the agreement between theory and the experimental data. The principal objective is the development of a psychology which is quantitative in the sense used in natural science. The Society plans to publish a journal. Dr. Paul Horst, Personnel Research Department, Procter and Gamble Company, Cincinnati, Ohio, is acting Secretary.

THE Statistical Service of the National Tuberculosis Association has just published a pamphlet entitled, "New and Supplementary Facts and Figures About Tuberculosis." It serves as a companion and complementary volume to the earlier publication, "Facts and Figures About Tuberculosis."

The pamphlet contains revisions of many of the tables in the earlier volume and also includes several new tables, particularly those from recent studies in relation to tuberculous infection. The pamphlet contains 38 tables covering up to date figures regarding the analyses of the tuberculosis death rates by sex, age, and color; contrast with other leading causes of death; tables regarding the results of tuberculin testing; tuberculosis classified according to the various forms, pulmonary and other; facilities for the care of the tuberculous such as sanatoria, hospitals and preventoria by states; etc.

THE BROOKINGS INSTITUTION.—The Institution has announced the award of thirteen fellowships for the academic year 1935–36. A number of these are given in co-operation with leading universities. The awards are as follows: Arthur R. Barnett, Cornell University; Edward G. Cale, University of Virginia; James P. Cavin, Assistant Professor at the University of Puerto Rico; Marius Farioletti, Instructor and graduate student at Duke University; Willard N. Hogan, Instructor at the University of Kentucky; Robin Hood, University of North Carolina; Charles M. James, University of Pennsylvania; Evron M. Kirkpatrick, Yale University; Phillip H. Lohman, University of Southern California; Edmond S. Meany, Jr., Harvard University; Vernon L. Phelps, Instructor at the University of Pennsylvania; Edmund J. Stone, Brown University; William Y. Webb, New York University.

Dr. Lewis Meriam of the Institute for Government Research has accepted an appointment as visiting professor of Public Administration at the University of Chicago for the academic year 1935–36.

THE SOCIAL SCIENCE RESEARCH COUNCIL.—The Social Science Research Council has announced the award of forty-nine grants-in-aid of research, totaling $22,725, for 1935–36. These grants-in-aid, designed to assist mature scholars in the completion of research projects already well under way, provide for study in economics, political science, sociology, cultural anthropology, social psychology, history, statistics, geography and related disciplines.

Among the awards are the following: Witt Bowden, Economist, U. S. Bureau of Labor Statistics, for a study of recent changes in the productivity of labor in England; Julian S. Duncan, Assistant Professor of Economics, St. John's College, for a study of the effects of the present national policies on timber growth and the consumption of forest products; Earl J. Hamilton, Professor of Economics, Duke University, for a study of John Law's system, the first experiment with a managed currency; Clarence A. Kulp, Professor of Insurance, University of Pennsylvania, for a study of the legislative and administrative coordination of a social insurance system; Arthur F. Lucas, Associate Professor of Economics, Clark University, for a study of the movement toward the control of competitive activity in British industry; Bruce D. Mudgett, Professor of Economics and Statistics, University of Minnesota, for a study of stability and instability in the price system as related to business fluctuations; Jeannette P. Nichols, for a study of the domestic and foreign policy of the United States on the silver question; Howard H. Preston, Professor of Economics, University of Washington, for a study of banking in Washington; Horace Secrist, Professor of Economics and Statistics, Northwestern University, for a study of national bank failures in the United States, 1921–32; Robert Weidenhammer, for a study of the feasibility and technique of a control of the capital market; Walter F. Willcox, Professor Emeritus, Cornell University, for a study of the demography of the United States; and Ruth J. Woodruff, Assistant Professor of Economics, University of New Hampshire, for a study of the American hosiery industry.

Applications for grants-in-aid in support of research during the period between April 1, 1936 and April 1, 1937 must be filed before January 15, 1936, on forms to be secured from the Secretary for Grants-in-Aid, Social Science Research Council, 230 Park Avenue, New York, N. Y. It is important that requests for application blanks include a brief statement of the candidate's research experience, the nature of the proposed project, and the approximate amount of aid required.

The Council has also announced the appointment of fourteen Post-Doctoral Research Training Fellows and twenty-six Pre-Doctoral Field Fellows with stipends totaling $88,000. The primary purpose of the Post-

Doctoral Fellowships is to broaden the research training and equipment of promising young social scientists, not to facilitate the completion of research projects or the continuation of investigations undertaken as doctoral dissertations. The purpose of the Pre-Doctoral Field Fellowships is to supplement formal graduate study by opportunities for field work which will assure first-hand familiarity with the data of social science not available in the classroom or library. The closing date for the receipt of application for both classes of Fellowships for the year 1936–37 is December 1, 1935. There is a third group of fellowships designed to aid exceptionally promising students of the social sciences to obtain research training beginning with the first year of graduate study. Applications for these fellowships should be made before March 15, 1936. Application blanks and information concerning minimum requirements may be secured from the Fellowship Secretary of the Social Science Research Council.

PERSONAL NOTES

Three American statisticians have been elected to membership in l'Institut International de Statistique recently. They are the Honorable William L. Austin, Director of the Census, Professor Joseph A. Schumpeter of Harvard University, and Stuart A. Rice, Assistant Director of the Census and First Vice-Chairman of the Central Statistical Board.

Professor William J. Carson of the Wharton School of Finance and Commerce is again acting as Executive Secretary of the Central Statistical Board in the absence of Dr. Morris A. Copeland, who is on leave for July and August.

Professor Paul R. Rider of Washington University, St. Louis, left for England on August 10 for a year of research at the Galton Laboratory under a Research Fellowship of the General Education Board.

Professor Wirth F. Ferger has been granted a year's leave of absence from the University of North Carolina to accept a position as associate economic adviser to the Secretary of Agriculture in Washington.

Edgar Sydenstricker was appointed Scientific Director of the Milbank Memorial Fund on June 1st. From 1920 to 1928, he was in charge of statistical research in the United States Public Health Service and since then has been consulting statistician to the Service and Director of the Milbank Fund's research staff.

NEW MEMBERS

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REVIEWS

Wages in Eighteenth Century England, by Elizabeth W. Gilboy. (Harvard Economic Studies, No. 45). Cambridge, Mass.: Harvard University Press. 1934. xxix, 297 pp. $3.50.

All students of economic history in general and of prices in particular know how defective among available price series are the particular series of the price of labor, or the rate of wages. To throw light upon the fundamental problems associated with changes in the standards of living of working populations would even in comparatively recent times require the meticulous accumulation of the raw data on rates of wages, earnings, and the cost of living. Mrs. Gilboy has undertaken to build up such a record for the crucial period of the "Industrial Revolution" in England. She points out, in characterising the figures heretofore available, that they were discontinuous, that the most accurate of them were for the end of the century, and that some of the collectors of them were conceivably subject to an unconscious bias. That these data, she writes, "have been almost the only known sources for studies of the laborer's condition at this date may account for the dark and dreary pictures of his life which have been painted for the second part of the century. They were all attempts to explain the miseries of the poorer classes in the latter eighteenth century. The authors themselves seem to ignore or minimize any indications that many of the poor were better off than they had even been before, even at the end of the century."

By a canvass of a great variety of local records, Mrs. Gilboy has succeeded in piecing together an extraordinarily interesting record of wage changes over the century of several important classes of labor. Through the cooperation of Sir William Beveridge she was enabled to use price quotations collected for the committee under his chairmanship and therewith to indicate probable movements of real wages, which greatly enhances the value of her study. Persuaded by her inquiries that the marked divergencies in regional movements of wages precluded useful generalizations on wages in the whole of England, the author deals separately with wages in London and that city's metropolitan area, in the West, and in the North of England. The main conclusions should be of interest to all students of wages. On the whole, wages in eighteenth century England show much greater stability than prices. There is a high correlation between industrial expansion and prosperity and prevailing wages and standards of life. Wages in the prosperous North, the area of the growing woolen and cotton industries, about doubled during the century, and their advance far exceeded the rise in prices. In the declining West, wages failed to rise, and the standard of living was low. The highest wages were paid in London, and "wages decreased in the London area as the distance from the metropolis increased."

Not the least valuable items in this book are the many stray bits of in-

formation on the clothes, food, amusements, perquisites which were available to English labor of this period and which throw such light on the rapidity with which standards of life were then changing. The comments which Mrs. Gilboy often makes on the meaning of her data should appeal particularly to those readers of the book who are concerned, as so many of us are today, with discovering the theoretical foundations for changes in wages and in the standards of life.

LEO WOLMAN

Columbia University

The Search for Truth, by Eric Temple Bell. Baltimore: Williams & Wilkins Co. 1934. 279 pp. $3.00.

This delightful and stimulating book is well worth the attention of all mathematical statisticians who are interested in the fundamental problems of method. It abounds in epigrammatic statements of such argumentative flavor as: "2440 A.D. will have forgotten everything about us except that we were a particularly moronic species of homo sap.," p. 51; "Science seldom makes a grand attack on a whole army of difficulties; it divides and conquers," p. 78; "Theory and experiment are the twin crutches by which science hobbles forward," p. 82; "not homosexuality, but extrapolation, is the most characteristic vice in which our age has imitated classic Greece," p. 84; "For all of three centuries the new masterpiece, . . (the second half of Aristotle) budded upon itself in a furious profusion of incredible gargoyles," p. 144; and "He (Leonardo) was one of the first to see clearly that deductive reasoning alone will get nothing but meaningless noises out of nature," p. 148.

Bell traces the activities of "homo sap." in the evolution of deductive reasoning and the relation of this activity to what men mean when they use the word "truth." The book is an abbreviated intellectual history of western civilization in four phases as these are reflected in and symbolized by advances in fundamental logic and mathematics.

Is there such a thing as truth? and What is the truth? were merely different phrasings of a question that has misled man for 6000 years.

Although the Egyptians in 4241 B.C. (the workable calendar) and in 1801 B.C. (formula for the volume of a truncated pyramid) took important steps in the search for truth, it was the Greeks who showed that deductive reasoning, rather than rules of the thumb, was a workable way to arrive at that common agreement upon which a stable civilization rests.

Pythagoras (6th century B.C.) opened the second phase with the first definitely recorded insistence on *proof* for statements about numbers and geometrical figures. Thus, an answer was right not because it was true but because it depended on prior agreement on a set of postulates. Yet the Greeks made the blunder of believing that deductive reasoning (Aristotle's three laws of thought) was the ultimate truth, and this tradition has fettered

the human reason for 2300 years. With grim certainty, scholars of the Middle Ages perpetuated belief in the absolute.

Although Zeno (495–435 B.C.) threw doubt on the universal applicability of deductive reasoning and although Galileo (1564–1642) was the originator of the modern scientific method (experiment), it was not until 1826 that the absolutism of Euclidian geometry was destroyed by the Russian Lobatchewsky. He invented non-Euclidian geometry and emancipated the mind of man from the perfections of deductive reasoning.

The fourth and most recent phase of the process by which closed systems of deductive reasoning have been destroyed was the creation in 1830 by Lucasiewicz and Tarski of numerous patterns of strict deductive reasoning which were radically different from the traditional logic of Aristotle.

The book ends with a pessimistic note of doubt. Are there not abundant signs that the period of enlightenment is drawing to a close and may be followed by centuries of intellectual darkness?

In spite of digressions, that are sometimes annoying, the book will repay more than one reading.

F. STUART CHAPIN

University of Minnesota

America's Capacity to Consume, by Maurice Leven, Harold G. Moulton, and Clark Warburton. Washington, D. C.: The Brookings Institution. 1934. 272 pp. $2.50.

This volume is the second in a series of four concerned with the distribution of wealth and income in relation to economic progress, a study conducted by the Brookings Institution with funds provided by the Falk Foundation. As its title suggests, the book is written for the intelligent public as well as for the professional economist.

In an outline of the subject of this treatise it is difficult not to paraphrase the excellent summary in the Foreword. Part I begins with a definition of the national income and continues with estimates of its amount and its trend from 1900 to 1929. Then in successive chapters there follow the distribution of the total income among the functional claimants, the geographic distribution among states, and the distribution among families and individuals by income groups. Part II is an analysis of the utilization of incomes, showing an allocation among savings and the expenditures for broad classes of consumers' goods and services. These estimates are set forth both by income groups and in aggregate, and the tendency for the proportion of savings to income to increase from 1900 to 1929 is indicated. Part III emphasizes the large increases in national production required to provide decent standards of living for persons in the lower brackets. Picking up the thread of the discussion from the preceding volume, *America's Capacity to Produce,* the final chapter shows the fallacies in various popular notions regarding over-spending, over-production, and limiting output, and in the course of

the discussion again notes the tendency toward concentration of incomes. The two statistical appendixes supply extensive supporting data, procedures, and references.

As one may gather from this résumé, the book consists almost entirely of statistical description. Except for some observations in the last chapter, inserted for the benefit of lay readers, the analysis of the relation of income distribution to economic progress and recommendations regarding national policy are deferred to subsequent volumes. But this book does afford an invaluable summary of data on a vital current issue. And those with a special interest in the field will find old series extended to more recent dates, many original estimates, and innumerable references.

From the point of view of statistical methodology, the major problems encountered are the critical appraisal of data, the synthesis of fragmentary distributions, and the analysis of totals by partial or secondary criteria. The validity of results from such procedures can be judged only by working over the same materials in detail. Without this experience, the reviewer can only report that there are present the indicia of technical ability, care, and common sense, which, *prima facie,* justify confidence in the results. The charts and tables likewise deserve favorable comment.

Through foresight, and possibly a little good fortune, the publications in this series have been coming from the press while the problem with which they deal has been assuming major political significance. By organizing their research so as to achieve timely publication and by making their findings intelligible to the lay reader, the staffs responsible for this work have rendered distinguished public service.

THEODORE O. YNTEMA

University of Chicago

British Association for the Advancement of Science—*Mathematical Tables.* London: British Association.

(1) Volume I—*Circular and Hyperbolic Functions; Exponential Sine and Cosine Integrals; Factorial (Gamma) and Derived Functions; Integrals of Probability Integral.* Prepared by: L. J. Comrie, A. T. Doodson, J. R. Airey, R. A. Fisher, A. Lodge, and J. Wishart. 1931. xxxvi, 72 pp. 10 shillings.

(2) Volume II—*Emden Functions, Being Solutions of Emden's Equation Together with Certain Associated Functions.* Prepared by J. C. P. Miller and D. H. Sadler. 1932. viii, 34 pp. 7 shillings 6 pence.

A committee of the British Association for the Advancement of Science has undertaken to edit, amplify, and republish such tables as have appeared from time to time in the annual Reports. On this committee were, among others, such well-known British computers as R. A. Fisher, J. Henderson, and L. J. Comrie.

(1) An elaborate introduction to Volume I deals with interpolation and illustrates the use of Everett's formula. Where they are necessary second, fourth, and sixth differences are printed in the tables. The introduction also contains well-documented descriptions of the various functions tabulated and ends with a long discussion of certain probability integrals which are useful to statisticians.

The tables are designed for workers who desire a high degree of accuracy, all values being given to ten or more significant digits. Sines and cosines are given for angles advancing by tenths of a radian as far as fifty radians and for angles advancing by thousandths of a radian across the first quadrant. Six pages are devoted to fifteen-place tables of hyperbolic sines and cosines of arguments advancing by suitably small intervals as far as 4π. Aften ten pages of "Ei," "Si," "Ci" functions, the remainder of the book is given to the gamma function and its relatives, digamma to pentagamma, and to tables of the multiply repeated (from minus 7 to plus 21) probability integral. Most of these latter tables were newly computed for this volume and have not appeared before.

(2) This volume, prepared under the joint sponsorship of the British Association and the International Astronomical Union, contains tables of Emden functions for $n = 1, 1.5, 2, \ldots 5$. These functions are solutions of a differential equation

$$D^2y + (2/x)\ Dy + y^n = 0$$

which is essential in the theoretical exploration of the internal constitution of the stars. The reviewer is unable to see for it any immediate statistical application. Auxiliary tables for interpolation are appended, and an extensive introduction shows how they may best be applied.

NORMAN ANNING

University of Michigan

(3) Vol. III. *Minimum Decompositions into Fifth Powers.* Prepared by L. E. Dickson, Professor of Mathematics in the University of Chicago. 1933. vi, 368 pp. 10 shillings 9 pence.

(4) Vol. IV. *Cycles of Reduced Ideals in Quadratic Fields.* Prepared by E. L. Ince. 1934. xvi, 74 pp. 10 shillings 6 pence.

(3) As the title indicates, this volume gives the minimum number of fifth powers into which a given integer n may be decomposed. For n less than 150,000, the actual decomposition is given; for n between 150,000 and 300,000 the number of fifth powers required is given. The actual decompositions can be readily found in the latter group, at most three trials being necessary.

The tables have been reproduced photographically from typescript; the result, although not as pleasing as the printed page, demands no apologies, and any slight loss in appearance is amply justified by the resultant freedom from errors introduced in the course of printing.

(4) It would seem that this volume is of interest principally to workers

in the field of algebraic numbers. For the reader who is not familiar with this field a brief but adequate account is given in the introduction.

Algebraic integers in the field $\sqrt{m}$ are defined as solutions of the equation $\xi^2 - 2u\xi + u^2 - mv^2 = 0$, m, u and v being rational integers, while u and v satisfy additional conditions which depend upon the character of m with respect to the modulus 4. Ideals associated with integers of the field $\sqrt{m}$ are defined, the concept of a basis is introduced and used to show that every ideal can be expressed in a particular form $(a, b + cw)$, a, b, c rational integers and $w = \sqrt{m}$ or $-\frac{1}{2} + \frac{1}{2}\sqrt{m}$ according to the character of m. Equivalence of ideals is defined and after defining a reduced ideal, it is shown that every ideal is equivalent to a reduced ideal. A similar process to that of reduction applied to a reduced ideal gives a second reduced ideal. A finite number of repetitions leads to the original reduced ideal and the set of reduced ideals so obtained form a cycle of reduced ideals.

The remainder of the introduction considers the notion of genera, defines primitive units, explains methods of calculation of the cycles, and discusses the relation between the cycles of reduced ideals, the expansion of $\sqrt{m}$ into a continued fraction, and the Pell equation. A short account of earlier related work is included.

The tables proper give, for all appropriate values of m less than 2025, the composition of m, the cycles of reduced ideals, the number of genera, the generic character of each cycle, and the primitive unit. The typography is excellent.

JOHN D. ELDER

University of Michigan

Contributi del Laboratorio di Statistica, Serie Terza, by Marcello Boldrini and others. Università Cattolica del Sacro Cuore. Milan: Società Editrice "Vita e Pensiero." 1934. 360 pp.

The volume under review, which is the third one published by the Statistical Laboratory, contains a dozen papers covering the three principal fields of statistical study, i.e., demography and biometrics, mathematical statistics, and historical statistics. Most of the papers, however, refer to demography and anthropometry.

Professor Marcello Boldrini's paper on "The Major Human Races in Europe" is a first attempt to base the classification of human races on inheritance of the principal racial characters. As such characters, pigmentation, the cephalic index, and stature have been chosen. The investigation yields the following ranking of races with respect to recessive heredity of these characters and freedom from intermixture: (1) the Nordic race, which is recessive in regard to all three characters; (2) the Mediterranean race, which is recessive only in regard to the cephalic index but relatively free from intermixture; (3) the East-Baltic race, which is recessive only in regard to pigmentation; (4) the Dinaric race, the existence of which seems to be

rather uncertain because it is recessive only in regard to high stature, which, however, may be a hybrid character, and also because of much intermixture; (5) the Alpine race, which is very uncertain because it is not recessive in regard to any of the three characters and because its formation can also be explained through cross-breeding.

Professor Albino Uggè devotes a paper to "The Similarity of Somatic Characters between Husband and Wife." Utilizing statistical materials referring to immigrant families in New York, the author has computed the correlation of a series of physical characters between husband and wife among different racial groups. The result obtained is that sexual selection is active not only upon visible characters but also upon characters which are scarcely discernible by the eye. The correlation between those invisible characters does not depend entirely on the correlation between the visible characters. The author, therefore, makes the hypothesis that in matrimonial choice, also, the affinity of temperament has an importance and that temperament is probably correlated with those physical characters which are not discernible by the eye.

In another paper Professor Uggè computes the center of population for Italy.

Dr. Alessandro Costanzo contributes a paper on "Constitution and Mortality." He shows on the basis of two samples of males that those of short stature are represented in a smaller degree among those who died still young, whereas among those of tall stature a higher frequency of pulmonary tuberculosis and diseases of the respiratory apparatus is shown. Among the tall type, however, victims of diseases of the circulatory apparatus and of the digesting system are less frequent. A paper on "The relation between Mortality and Stature," by Dr. Salvatore Alberti, seems to support the view that mortality in the first 20 years of age hits prevailingly the taller individuals. Dr. Francesco Giglio gives a systematic survey of the basic demographic phenomena in Italy with regard to the altitude at which the population lives. He shows a tendency of the Italian population to settle in less high territories.

The field of historical investigation is represented by a paper by Professor Albino Uggè on "William Derham and the 'Divine Order' in the Manifestation of Demographic Phenomena" and two papers by Professor Amintore Fanfani: "The Revolution of Prices in Milan in the 16th and 17th Centuries" and "Contributions to the Demographic History of Tuscany." Professor Uggè's paper on Derham throws an interesting light on the philosophical background of the school of Political Arithmetic in the 17th and 18th centuries and shows Derham to be a predecessor of Süssmilch in deducing the existence of a divine order from the regularity of demographic phenomena.

Mathematical statistics is represented by three papers of Professor Pietro Martinotti: "A Method for Computing the Rates of Elimination," "Interpolation and Trigonometric Series," and "On the Mean Altitude of Demographic Phenomena." In his paper on interpolation, Professor Martinotti discusses the interpolation formula of Lebesgue which is derived from Lagrange's formula through substitution of the values of the variable by their sines.

The convergence of the Lebesgue formula is studied, and through transformation of this formula a trigonometric series is obtained.

The papers collected in the volume testify very highly to the activities of the Statistical Laboratory in which they have been produced. The broadness of view and the synthetic approach combining different fields of statistical investigation are of particular merit. It ought also to be mentioned that an English summary is added to each paper.

OSCAR LANGE

The University of Cracow, Poland

The Twilight of Parenthood, by Enid Charles. New York: W. W. Norton & Company. 1934. vi, 226 pp. $2.50.

Sooner or later a book of this title was sure to appear. We have had the "decline" of this and the "close" of that. Now parenthood is to join with the white races to go out through the deepening twilight to—to what? If we take the word of certain scientists who get hold of an idea outside their own special fields of knowledge and elaborate it for popular consumption in a book for which a catchy title is devised, and who do not hesitate to extrapolate indefinitely on a few years or decades of statistical series, parenthood and the race are headed toward extinction. This at least is the sensational suggestion they dangle before the uninstructed public.

Dr. Charles' book, however, although there is much in it to criticise and although it is a book that the reviewer would hesitate to recommend to the general reader unfamiliar with recent thought and research in the field or population, is a much better production that the title would lead one to expect. Dr. Charles is occasionally incautious, even a bit sensational, in phraseology, but in her last chapter she shows thoughtfulness and balance and an insight into some of the significant economic and psychological implications of the problem of contraception and declining fertility. Repeatedly, however, she speaks as if fertility and fecundity were the same thing, indicating a lack of acquaintance with vital statistics except for the work of Kuczynski and Pearl's logistic. She speaks (p. 2) of "a civilization which has lost the power to reproduce itself." She asserts (p. 105) that industrialism is a biological failure because it has "lost the capacity to reproduce itself." And even in the last chapter, where she holds that capitalistic industrialism is responsible for the approach of a declining population, she still confuses fertility with fecundity, biological with social or psychological:

> "Thus the fundamental issue raised by our inquiry into the conditions of population growth in modern civilization is whether any possible modification of a society which depends on the incentive of private profit could suffice to counteract its biological incapacity for perpetuating itself" (p. 206).

Dr. Charles starts with the thesis that the population problem is a prob-

lem in ecology, apparently under the impression that perception of this fact is new and that the economists are blithely oblivious of it. Whereas the fact is that the few economists who today, in the welter of more immediately pressing problems, are reserving time for study of population are almost the only students of population who perceive the problem in terms of factoral proportions—which is what ecology in the last analysis amounts to. Having discovered Kuczynski, Dublin and Lotka, and Thompson and Whelpton (but not the German literature), she implies that the economists have been quietly vegetating for the past ten or twelve years, and that they still think that pressure of population upon subsistence is an early danger. She thus makes a considerable stir in knocking over a straw man. In the United States, at least, where the Federal Government has had to pay some hundreds of millions of dollars to induce farmers to "not raise" so much wheat and cotton and so many hogs, this sort of thing is simply humorous. Yet in the long run Dr. Charles' confidence that the world need never worry about its food supply is perhaps not wholly justified. Irrigation, nitrogen fixation, and hydrogen ionization are not the whole story. It is more than probable that the future limiting factor in agriculture will be the dwindling supply of phosphates, which Dr. Charles does not mention. She also ignores the problem of erosion, which is now beginning to claim greatly belated attention in this country. Moreover she advances the counsel of perfection: our food production could be increased many times without increasing the area of cultivation "if mankind exploited to the fullest extent all the scientific knowledge available" (p. 30). This is true, long recognized as true. So was Sir George H. Knibbs' estimate that the earth could be made to support seven or eight billions (compared to the present two billions) if the nations would desist from their differences and pool all resources in one great world communism. Speculations, however, on what would happen if everybody was efficient and nobody selfish have little practical value. Without talking perfectionism, we can all agree that the western world at large does not have to worry much about food supply for the next few decades at least.

Even in its purely quantitative aspects, however, the population problem is not so simple as this. There are basically important considerations which escape Dr. Charles' notice; the rationalization of industry, for instance, and the technological unemployment which bid fair to make the approach of stationary or even declining population a social and economic boon. And does Dr. Charles think that even a communistic or a corporate-state régime could restore the prosperity of the coal and iron and textile industries of England? Foreign markets seem to have something to do with population capacity.

In the end, however, Dr. Charles shows her good sense: "To abandon family limitation is not practicable. Even if it were it would involve a sacrifice of human health and happiness and one of the instruments of a rationally planned ecology of mankind" (p. 194).

A. B. WOLFE

Ohio State University

Liquid Claims and National Wealth. An exploratory study in the theory of liquidity, by Adolf A. Berle and Victoria J. Pederson. New York: The Macmillan Company. 1934. xvi, 248 pp. $2.50.

The controversy about liquidity emerged when it became possible for a bank to take either of two courses. The first course was the loan of money to merchants facilitating the flow of goods for final consumption. Wheat, for example, moves towards a hungry mouth, steel towards a final resting place in a girder or fixed rail. Either is liquid while it is still moving. The final consumption good, of course, ends its career with consumption; the more durable property ends its liquidity when it reaches its final destination where it is consumed or depleted at a much slower rate. The second course was the loan of money on securities aimed either to create fixed assets or to assist an owner in "carrying" these securities until they could be resold. The controversy concerning whether this latter use of credit was orthodox and sound has continued up to the present time and is not ended yet.

The authors accept in the main the conventional idea about liquidity and also accept the conventional reasons for it, but they limit their interpretation to its mechanistic respects. The essential point made by the authors is that the operations by which an asset may be converted into cash turn necessarily on the legal mechanisms. These operations are of two kinds, and only two. Either the asset is in the form of a claim—that is, a loan, repayment of which can be required—or it is in the form of property or a claim which can be quickly sold. In other words, liquidity is achieved either by an assumption of ready repayment of a loan or of ready sale of an asset.

It is continuously argued that the system must provide ready exchangeability into *cash*. After denoting cash as the ultimate goal of liquidity they argue that the liquidity even of gold is "artificial. . . . It is interesting to see how deep-rooted these customs can become; though of their artificiality there is little, if any, question. When the mythical Midas first set his seal on gold and called it currency, he started a fashion so that even today, in great areas where gold is asserted to have no more monetary quality, men still gather it believing that other men will accept it as money—because it has for ages been money, and presumably will be so again. This is the liquidity not of satisfaction but of acceptance. . . . In the study of artificial liquidity we are really studying the creation of mechanisms which make particular forms of wealth acceptable. The claims on fixed assets which are created by these mechanisms satisfy no material need; they fulfill no human desire."

With this cash complex, the authors reach the physiocratic notion that treasure is almost by hypothesis a dead thing, which wastes itself as it is used in fulfillment of desire. Of itself bullion or money can do nothing. Until something else is done with it, it is non-productive.

But convertibility into cash in the sense in which they have used the term is not the fundamental problem. The required conversion is largely into claims against *present* purchasing power. The whole matter of liquidity has to do not with *cash* but with the question of facility in the exchanging of

future for present purchasing power. Present purchasing power may or may not be cash. The notion of absolute liquidity and "cash" are anachronisms which bar the way to a true understanding of the real issues involved, which have to do with a credit system. One may question the essential validity of basing fundamental propositions upon merely institutional settings since it leads to a mechanistic approach and interpretation and at best yields only a "first approximation" of the truth.

They do not see the real issue in the problem of liquidity. It is not really a question of being able to convert into cash—this is merely a special case where a purely pragmatic criterion is set up to give the end of sound practical banking. The real definition of liquidity is none of these but should have advertence to the general economic system. It is an abstract concept for the purpose of guiding sound banking principles, in its most limited aspect, but more generally its purpose is to aid in the interpretation of the modern credit system. The authors are apparently groping towards just such a generalized concept but try too zealously to give it objective expression and statistical meaning. They almost see the reality when they say "The resulting liquidity really rest only on a figment" of the organization of financial institutions, but when they do they make a caricature of it, largely owing to their intense desire to disclose the inherent weakness of capitalism. Furthermore, there is an unfortunate identification of the commercial bank liquidity theory and the consumer purchasing power theory for ending the depression.

While they recognize time as a factor and draw a "liquidity curve" in the setting of the time element and a concept of "going price" the presentation is not at all clear. Of course the real fundamental matter *is* related to time. It is this: how much future means of payment should be converted by the banking system into present purchasing power? The authors fail to explore this aspect of the importance of time as a factor.

Apparently they failed to see that all these liquid assets represent "valuations" of things rather than the things themselves. They failed, therefore, to visualize the process of capitalization in terms of a valuation process itself dependent upon the psychological element of time preference. Instead they were content to view the mechanism as it discloses itself objectively—its very objectivity concealing the basic and fundamental problems involved.

The authors' real climax comes in their "catastrophic" description of the great increase in liquid forms. This was the thesis they really wanted the public to read. The rest of the book is just frill and decoration to their pet thesis. They want to show we are in a revolution or historical crisis. They hold to the menopause theory of history. Here we find the inward purpose of the book in the authors' hobby; and it is based on a rather tenuous relationship with the facts they call to witness.

After all what does the great increase in proportion of liquid forms mean? Setting up their own definition of liquidity they calculate on that basis the enormous increase in liquid claims. By their definition of liquidity there is nothing alarming about this increase, but to the uninitiated the statistical inference will be startling because of the enormous increase in liquid claims.

"And a speculative mind may well ask whether in the next phase there will be an orientation towards support of the machinery of liquidity in its present ratio, or whether there may not be a retreat towards the line of the older ratio. Of that retreat, however, there is at present no sign." But why should it be expected or even desired? "Artificial liquidity" by definition is after all artificial.

Their figures on liquidity show an increase from 1890 to 1910 of one-third, and from 1910 to 1926 an increase from 20 to 28 per cent; from 1910 to 1933 an increase from 20 to 34 per cent. The peak of 40 per cent occurs in 1930. With this background they speak of the period 1880 to 1910 as symptomatic of the somewhat quiet, peaceful life which effloresced in what we now call the late Victorian age. By contrast the latter period draws forth this awe-inspiring comment: "The mere shift in quantity and proportion would be significant enough. But the rate of speed at which this proportionate increase went on is (in terms of historic-economic cycles) almost breath-taking. . . . It is as though a glacier which had moved at the rate of half a mile a year for a century suddenly pushed forward fifty miles in ten years. There has been neither the time nor the thought to work out adjustments comparable to change at this rate of speed." Again, "plainly the figures reflect a reorientation of life. Plainly the instinct to have ready cash either to satisfy desire or to allay fear became in that decade an instinct requiring the satisfaction beyond all measure; . . ." "Only a real shift in desires, a real change in life, of proportions entitled to be taken into account as a historical force, could result in such a shift." One might suggest that similar "fundamental" forces created the Mississippi Bubble.

The authors seem to feel that they have uncovered in liquidity the basic flaw in capitalism or its inherent disintegrating force. In substance we become a socialist or communist state, private ownership of physical property being substantially eliminated by liquid forms of ownership. It appears to be a fact that the increase in the demand for liquidity almost of necessity weakens a civilization based on individualism and individual property. There is something lost as the picture expands. That is the individual. His relation to physical property; or, indeed, his certainty of a place in the scheme at all, diminishes almost to the vanishing point, until he reappears again either as the ward of the government through a dole, or as a cog in a private mechanism prepared to undertake almost the same responsibility.

In another highly imaginative mood they say: A world in terms of liquidity does, it is true, satisfy a certain mathematically logical desire for a world of complete mobility. But men are obstinate enough to form attachments: to occupations, to homes, to land, to a familiar process of life, to being useful in a particular way. No doubt it is possible to satisfy those human instincts irrespective of property; indeed, one result is that men are thrown back on their attachments to other human beings in far greater degree than ever before. But this involves a revolution in the technique of living; and none will say that the problem has yet been successfully solved. . . . "There is no escape from the fact that the truly liquid asset is a dead asset; as it enters

into production it becomes less liquid; what has happened has been the splitting of the atom of property so that he has the dead part, and someone else the living."

One is forced to the conclusion that their mechanistic formulas and mysticism make brilliant writing but fail to guide towards a true understanding.

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Who Gets the Money?, by Walter Rautenstrauch. New York: Harper & Brothers, 1934. 98 pp. $1.00.

Professor Rautenstrauch classifies all property income (except income from agriculture flowing to farmers) and all labor income originating in the fields of trade, government, finance, and services as overhead costs of the national economy; and attempts to demonstrate that the ratio of these overhead costs to productive costs (i.e., incomes of farmers and of labor in mining, manufacturing, electric light and power and gas utilities, construction, transportation, and communication) has risen markedly from 1917–18 to 1932. This increase in overhead costs is then diagnosed as the main trouble of our economic system and as a potent source of our present depression. A number of charts are assembled in a section entitled "a technical report," in graphic support of the same set of conclusions.

The study is offered as an engineer's analysis of our economic system, in the hope that the use of an industrial engineer's point of view and vocabulary will produce results worthy of attention. This reviewer must report that such is not the case and that the little book is marred by a failure to understand the functioning of a social economy and by unpardonable ignorance of the sources of basic data on the subject treated.

The definition of overhead costs provides an example of what happens when the philosophy of a consulting industrial engineer, which is that of an individual entrepreneur in industry, is transferred bodily to the treatment of a country's economic system. It leads to such results as the classification of the costs of communication activities of the government (e.g., the postal system) as an overhead cost, although outlays for a similar activity by private companies (such as telegraph) are classified as productive. Trading and the rendering of medical services are unproductive, but the manufacturing of advertising posters and medicines, included among the totals for manufacturing industries, is productive. An example of unfamiliarity with the more empirical elements of economic knowledge is the use of the data for 1917 or 1918 and those for 1932 as two basic points, the comparison being justified by the fact that national income totals in current prices were about the same for the two years. It does not occur to the author that 1917 was a year of rising prices and expanding activity, while 1932 was marked by an acute price decline and a contraction of activity; and that what he con-

ceives as a secular change between these two years may be largely a recurrent difference between the peak of a cycle and its trough.

Of the numerous statistical errors made by the author, only a few need be mentioned. To begin with, the data for 1929–1932 are quoted from the National Industrial Conference Board *Bulletin* of May 10, 1934, which is a brief summary of the detailed data and explanations presented in the report to the United States Senate on *National Income, 1929–1932* (Senate Document No. 124, 73d Congress, 2d Session). A perusal of this report, which was published a month before the appearance of the National Industrial Conference Board *Bulletin,* might have spared the author many improper comparisons between Dr. King's estimates for the years 1919–1928 and the estimates it provides for the years 1929–1932. Whether because of this ignorance of basic sources or for other reasons, Professor Rautenstrauch treats estimates of the number of gainfully occupied persons *attached* to certain industrial divisions (for the earlier years) as comparable with the equivalent numbers of fully *employed* persons (for the later years). Although the difference in the two divisions is recognized, income from banking in 1917 is compared with income from finance in 1932, the latter division including insurance and real estate in addition to banking. Comparisons are drawn between income originating from trade in the two sets of estimate, although Dr. King's estimates were made before the data for the Distribution Census for 1929 became available and have to be revised in the light of these data. Total income paid out in 1929, as given in the Senate report, is compared directly with Dr. King's total for 1928, and although the income shows a drop from 1928 to 1929, this surprising decline does not induce Professor Rautenstrauch to reexamine the comparability of the two sets of estimates. Finally, the author considers that entrepreneurs (exclusive of farmers) receive all the dividends, interest, and rents paid in the country and thus obtains an absurd per capita figure for property income of $5,025 in 1932.

One would willingly accord this book the only treatment it deserves, namely, silence. But such books have a harmful effect on those people whose critical temper and substantive acquaintance with the problems and data in this field are not sufficiently developed to permit them to see through the engineer's jargon. In so far as this book is likely to have any influence, it will only foster misunderstanding of the problems besetting modern economic society.

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Statistique et Applications, by Georges Darmois. (Collection Armand Colin, N. 174). Paris. 1934. 201 pp. 12 francs.

A few years ago Professor Darmois published a short but original introduction to mathematical statistics.[1] The book made a distinct place for

[1] *Statistique Mathématique,* Paris, Librairie Octave Doin, 1928.

itself in the continental literature by its clear elaboration of the probability basis of mathematical statistics. Considerable interest, therefore, is attached to his attempt to write a popular book on statistics and its applications, but his new publication does not live up to the promise of its predecessor.

In a volume addressed to the laymen, care should be taken not to use the theory of probability without sufficient explanation, and the emphasis should be on the logical side of statistical methods. Of course, this task is a very difficult one, but Tchuprow has shown how it can be done. Professor Darmois sometimes uses quite complicated formulae, without explaining their logical significance step by step. The analysis of many examples from different fields is very stimulating, but the unprepared reader will have to overcome some difficulties. The examples are from economics, biometry, psychology, physics, agriculture, and even astronomy. The statistician probably will not find much that is new to him, except in occasional remarks like those in chapter X on R. A. Fisher's study of the correlation between rainfall and the yield of wheat per acre. The economic questions discussed include population (chapter III), indices of business activity (chapter IV), and business forecasting (chapter XI). These parts are perhaps too fragmentary. Particularly it is to be regretted that the author did not incorporate the results of his remarkable paper on time series: "Analyse et comparaison des séries statistiques qui se developpent dans le temps," *Metron*, vol. VIII, 1929.

EUGEN ALTSCHUL

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The Agricultural Situation in 1932–33, by International Institute of Agriculture. Economic Commentary on the International Yearbook of Agricultural Statistics for 1932–33. Rome. 1934. viii, 580 pp. 25 liras.

This is the fourth volume of the series of Economic Commentaries published by the International Institute of Agriculture. No essential modification has been made in the plan followed in the preceding volumes, but the introductory chapter of the present publication, in which is discussed tendencies in world agriculture (written by Dr. G. Pavlovsky, under whose direction the greater part of the book was prepared), is larger than usual and presents more general interests. In this chapter the author emphasizes the structural changes in the world's economic organization, particularly the rapid growth of the idea of planned economy in agriculture, which has to supersede to a certain degree the very essentials of competitive economy.

In connection with the growth of planned economy and the increased intervention of governments, the fourth chapter, giving information on government measures of farm relief, also acquires greater importance in the volume. It occupies more than one-fourth of the whole and supplies valuable information on numerous measures taken during 1932–33 for the relief of agriculture by various governments throughout the world. Chapter V, dis-

cussing action taken by voluntary organizations in the interest of producers, is of lesser importance. The great increase of state intervention in agriculture and of economic planning, in which the initiative is taken by government, doubtless has in some countries reduced the importance of the voluntary organizations of farmers. For instance, the promotion of marketing schemes under the Agricultural Marketing Acts of 1931 and 1933 in Great Britain had the effect of limiting the field of voluntary cooperation. The last chapter (VI), supplying information on economic conditions of agriculture in various countries, is useful for reference. It may be summarized by saying that in almost all countries agriculture continued to be in a state of depression in 1932–33 but that there were signs of improvement, which was produced by the intervention of governments rather than by way of natural recovery.

The growth of planned economy and increased governmental interventions in agriculture occupy, in such a manner, a central position in the present volume. The author of the introductory chapter says that the world has turned to planning as a solution of its economic and social problems. But, at the same time, he emphasizes that the advent of planned economy tends to create problems and difficulties of its own and that transition from competitive to planned economy is not accomplished smoothly and painlessly. Furthermore, he says, "unless and until some of the problems created by the transition to planned economy find a satisfactory solution . . . the standards of life will generally be lowered as compared with those attained under the competitive system."

The author emphasizes the particularistic and nationalistic tendencies characteristic of planned economies and states that under a system of national planning, international economic relations are necessarily restricted, which will inevitably result in a general lowering of the standards of life. In his opinion "the consolidation of the new order will depend on its success in finding a solution to the problem of international economic cooperation." The future of planned economy, he believes, will depend on its capacity to devise and to put into effect a workable scheme of international economic cooperation between planned national economic units. The author thinks that modern commercial policy tends gradually to forge necessary new links between the now largely isolated national units by the development of contractual cooperation between countries *economically complementary* to each other. But will not such bilateral agreements between complementary countries (those purely agricultural on one side and purely industrial on the other) hamper still more the trade between other, less one-sided, intermediate countries, particularly if the interpretation of the most-favored-nation principle becomes more and more restrictive? The difficulties that the United States experiences at the present time in the conclusion of bilateral trade agreements may illustrate the situation. Being neither purely agricultural nor purely industrial but agricultural-industrial at the same time, the United States has difficulty in finding *complementary* countries with which to conclude the bilateral agreements.

The detailed presentation of governmental measures on farm relief, and particularly the generalization and interpretation of these measures in the introductory chapter, is the most interesting part of the book and may be recommended to the attention of all who are interested in the present economic tendencies in world agriculture.

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Security Speculation, Its Economic Effects, by John T. Flynn. New York: Harcourt, Brace and Company. 1934. 332 pp. $3.00.

In this volume, which appeared shortly after the passage of the Securities Exchange Act of 1934, the author attempts "to make at least a beginning in the business of scrutinizing the part played by speculation in our economic life." Actually his attempt is not as pretentious as this statement would indicate, for Mr. Flynn restricts his efforts to an appraisal of speculation in securities, which he defines as "an operation in which one buys or sells securities, with the design to make a profit out of the changes in the market price of such securities." That speculation, as the general function of risk assumption, is an inevitable and useful aspect of the development and operation of capitalistic enterprise, the author freely admits. But he makes a useful and needed distinction between the important, but secondary, part played by speculation in the development of new industries, such as the railroads and the automobile industry, and the kind of speculation involved in pure security trading on the organized stock exchanges.

The latter type of speculation he subjects to critical examination with the view of discovering and describing the mechanism and devices by which it is conducted, evaluating its effects upon the economic system in the light of the contentions of its proponents and demonstrating the type and extent of regulation needed to correct the evils which he believes to exist.

The stock exchanges, Mr. Flynn finds, are the means of permitting and fomenting an enormous volume of security speculation, which, though participated in by "three or four thousand insiders and some half a million outsiders," performs none of the useful functions usually ascribed to it and has widespread harmful repercussions throughout the entire economic system.

The orthodox contention that the organized security markets, by facilitating speculation, provide continuous prices and a ready market for securities, without which the flow of savings into investment would not take place and the financing of new enterprises would be impossible, Mr. Flynn regards with an agnostic eye. The capital for new enterprises and new industries such as steel, automobiles, and the railroads, he points out, was obtained in the first instance by the sale of bonds (in which the stock exchanges are a negligible factor) or by private financing without benefit of the stock market. Speculators in the organized security markets, he admits, do provide a continuous market for the existing stocks of established corporations. A

continuous market, however, is not necessarily an "efficient market," nor is its existence essential in order to induce the investor to place his funds in either new or old enterprises. Speculation on the stock exchange, then, is not essential to the financing of corporate enterprise and the functioning of the economic system. Rather, it is an activity of, by, and for the speculator and without any other justification.

Aside from the fact that it serves no useful purpose, the author finds that organized speculation on the scale which existed during the late bull market is characterized by practices, such as the excessive use of credit in margin buying, pool operations, price manipulation, and the activities of specialists, floor traders, and other insiders, which have unfortunate effects not only on the unwary outsider lured into market during a boom but on the national economy as a whole.

The author believes that the remedy for the many evils arising from speculation on the stock exchanges lies in effective Federal regulation designed not only to eliminate dishonest and harmful practices but to reduce substantially the volume of speculation, which now employs "ninety per cent of the energies, funds and mechanisms of such exchanges."

The last chapter of the book contains a critical analysis of the Securities Exchange Act of 1934, which the author believes is a step in the right direction although deficient in many important respects. "The law itself, as it stands," he states, "forbids and requires so little that we may truthfully say there is no body of laws as yet governing the securities markets until the commission considers, adopts and promulgates them. We shall have to await that even before forming a judgment of the value of our experiment."

As an effective and vigorous exposure of the malpractices which characterized the fabulous bull market and its aftermath, this volume can be unhesitatingly recommended. But it is primarily a journalistic accomplishment, albeit an excellent one. As a judicial inquiry into the effects of security speculation in our economic life, Mr. Flynn's accomplishment leaves something to be desired. One cannot escape the impression that he has approached his task in the manner of a prosecuting attorney and with the zeal of a reformer and not as the scientific investigator bent on impartial inquiry and evaluation. As an attempt at economic analysis, the book, at least in the opinion of this reviewer, suffers in another important respect: the failure to recognize that the use of "created" bank credit in the purchase and carrying of capital securities is the economic root evil to which all the malpractices and other secondary evils which invariably attend a speculative orgy can be traced. When bank credit can be "created" to finance the purchase and thereby boost the price of equity securities, which in turn makes possible the creation of additional credit to boost prices still further, and this vicious upward price spiral coincides with or engenders a boom psychology on the part of the outside public, the stage is set for a destructive bull market with all its attendant evils. When the circus comes to town the pickpockets and shell-game operators are sure to accompany it and to ply their trade among the "suckers" in spite of all the efforts of the police. Efforts to eliminate

evils by prohibition or by direct regulation of questionable practices should not be discouraged, but not too much should be expected of such measures if the conditions conducive to speculative excesses are allowed to exist.

FREDERIC DEWHURST

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Změny v cenách velkoobchodních a jejich měření (Changes in Wholesale Prices and Their Measurement), by Leopold Šauer. Prague: Orbis. 188 pp.

Dr. Šauer, a member of the staff of the Czechoslovak State Statistical Office and of the faculty of the Graduate School of Commerce at Prague, recently spent two years in the United States as Fellow of the Rockefeller Foundation, devoting himself to the study of modern American statistical technique. On his return he undertook the task of analyzing available Austro-Hungarian and Czechoslovak price data.

His material consists of the wholesale prices of 43 to 45 commodities in Austria-Hungary in the period 1867–1909 and of the wholesale prices of 69 commodities in Czechoslovakia in the period 1922–1933. His treatment of this material is painstaking and thorough. He presents a number of indexes, several measures of dispersion, a measure of price shifts, six trend curves, a computation of cyclical fluctuations, an account of the distributional nature of the price relatives he used, estimates of the probable errors of two series of index numbers, and a detailed summary of the behavior of the prices of individual commodities and commodity groups.

The indexes of wholesale prices in 1922–1933 exhibit several curious characteristics. The passage of time seems to have had no effect on the dispersion of price relatives, even when the prices of 1914 were taken as basic, as the State Statistical Office does. Yet their dispersion varies remarkably from year to year. Mills' index of dispersion declines steadily during the prosperous era of 1924–1928, attaining a minimum of 14.6 in 1928; it increases no less steadily in the subsequent epoch of economic distress, reaching a maximum of 27.1 in 1932. This bit of Czechoslovak price history would seem to contradict Wesley C. Mitchell's interpretation of price behavior, based on the study of the 1890–1910 period in the United States (*Business Cycles*, 1913, p. 110), and to add force to Oscar Lange's interpretation based on the American experience of 1891–1926 (*Die Preisdispersion als Mittel zur statistischen Messung wirtschaftlicher Gleichgewichtsstörungen*, Leipzig, 1932, pp. 34–35). Mitchell in his early work on business cycles argued that prices tend to "bunch up" in a period of price depression; Lange found the opposite to be true. Dr. Šauer, however, hesitates to cast his lot with Lange; he concludes that "post-war economy has become far more complicated than pre-war economy; to the specific factors influencing the development of price dispersion, a new, extremely important factor has been added: artificial interference with price formation. Specific influences may cause a rise in

price dispersion in times of crises, i.e., when economy as a whole is out of balance. This is understandable. But . . . the process of liquidation . . . should normally result in a consolidation of the general assortment of wholesale prices. Yet the dispersion of the series of fixed-base price relatives increased in 1931–1933, although these years were, in Czechoslovakia, years of pronounced economic depression. This is not merely contrary to all logic: it is an unfortunate fact for which our economy will have to pay a heavy penalty in the form of retarded progress." He may be right; but is the statistical concept of stability a valid counterpart of the economic concept of the stable equilibrium?

The indexes of price shifts, computed by means of Mills' modification of Spearman's rank-correlation formula, lend some color to the theory that prices tend to shift more during the phase of economic revival than during the phase of business recession. But what amazes one is the huge month-to-month price displacements registered in Czechoslovakia throughout the years 1928–1933. In this period, the index of price shifts never fell below 0.48 and ran as high as 1.08.

Another unexpected conclusion is derived from a study of a number of frequency distributions of price relatives. These distributions show a high degree of kurtosis but a negligible degree of skewness. For example, 4920 month-to-month price relatives drawn from the material for 1923–1928 are grouped as follows: 30 per cent above 100, 30 per cent below 100, 40 per cent at exactly 100. The frequency distributions of the logarithms of these and other price relatives mentioned in the text are not appreciably nearer to a Gaussian distribution than the frequency distributions of the price relatives themselves.

In spite of the dubious distributional nature of his data, Dr. Šauer found it advisable to compute the probable errors of two of his indexes, relying on the formula which is least objectionable for this purpose, that of "quartile deviation divided by the square root of the number of independent price series." Out of the original 69 price series, 56 were deemed to be mutually independent. An application of this formula brought into high relief the basic structural weakness of the official wholesale price index of the Czechoslovak State Statistical Office.

This official index is derived from prices secured simply by the process of collecting lowest and highest actual price quotations on or about the first day of each month and striking an arithmetic average of the two extremes. For some unknown reason the spread between the lows and the highs has amounted, on the average, to about one-fifth of their mean. Dr. Šauer achieves a dramatic demonstration of the consequences of this circumstance by constructing two additional indexes, one based on the lows, the other on the highs, and by computing their respective probable errors. In December, 1933, for example, the index of the State Statistical Office stood at 650 (July, 1914 = 100); the lowest-quotations index stood at 579; the highest-quotations index registered 714. The probable error of the lowest-quotations index was 25; that of the highest-quotations index was 23. The complete

table suggests that, ever since its inception, the official index has been improbably high in comparison with the lowest-quotations index and improbably low in comparison with the highest-quotations index.

It is, of course, possible that the probable errors given by Dr. Šauer are too small; there can hardly have been as many as 56 truly mutually independent price series out of a total of 69 representative series. Yet this statement does not invalidate his criticism of the official index number. He is correct in pointing out that in times of price recessions the bulk of contracts entered into is usually consummated at prices close to the reported "lows," and in times of rising prices most of the commodities dealt in will have been disposed of at prices close to the quoted "highs." Undoubtedly, the Czechoslovak State Statistical Office index tends to minimize price-recessions and price-revivals alike; though perhaps the bias is in favor of a more correct treatment of rising than of declining prices.

Such flaws in statistical procedures may have unlooked-for economic and political repercussions. In 1933, Czechoslovakia decided to devalue the gold crown; the degree of devaluation fixed upon was 16⅔ per cent. Since then, it has become apparent that a greater degree of devaluation would have been more in line with the disparities which this policy endeavored to correct. Would not a greater degree of devaluation have been chosen if it had been known that the official price index underestimated the size of the fall in the price level from 1928 to 1933? A nation's destiny is balanced nowadays on the hair-line of a statistician's slide rule!

It is a pity that no review can do justice to Dr. Šauer's twenty-one elaborate tables and twenty striking charts. They represent a definitive analysis of his interesting material; it can safely be said that the job he undertook to accomplish will not have to be done over again.

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